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ANNALS *of* SURGERY

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STUDIES ON THE LOCALIZATION OF CEREBELLAR TUMORS

THE POSITION OF THE HEAD AND SUBOCCIPITAL DISCOMFORTS

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IN patients with cerebellar and extracerebellar tumors the head is frequently held tilted toward one shoulder. The face may be turned toward the opposite side or directed forward. Often occipital headache or neuralgia, local tenderness, and stiffness of the neck muscles also form striking features of the patients' syndromes. In establishing a differential diagnosis between supra- and infratentorial lesions and drawing conclusions regarding the localization of tumors which appear to involve the cerebellum the question frequently arises as to the proper interpretation of these signs and symptoms. Notwithstanding the comprehensive literature which pertains to diseases of the posterior cranial fossa, the significance of the position of the head and of suboccipital discomfort still remains uncertain.

The object of this study has been to secure information concerning these features in order to appraise correctly their diagnostic importance in the routine examination of such patients. To accomplish this end a series of 60 cases, in which the presence and situation of the lesion have been certified, has been selected from two hundred odd patients with cerebellar or extracerebellar new-growths. In these the clinical observations concerning head posture and suboccipital distress have been correlated with the data subsequently obtained from the operating and post-mortem rooms.

Similar analyses of other so-called cerebellar tumor signs have been discussed elsewhere.^{6, 7, 8}

The records used in this work are from patients who have appeared in the neurological services of Dr. Cushing at the Johns Hopkins Hospital previous to September, 1912, and at the Peter Bent Brigham Hos-

pital since that date. Most of the cases in the latter group were personally studied by the writer. All records have been excluded which showed that the disease had extended into other parts or which included additional factors likely to confuse the symptom-complex.

In addition, for purposes of comparison, the records of 43 patients from the Brigham Hospital Clinic with certified supratentorial tumors have been analyzed for the presence or absence of these signs.

It is difficult in many cases of cerebellar tumor, especially where the growth is extensive, to be certain whether the assumed position of the head is due to the new-growth itself or to pressure on nerve-paths in its immediate neighborhood. For clinical purposes, however, it makes little difference how a tumor affects the posture of the head provided its localization is correlated with the change in attitude which it brings about. It is convenient for purposes of analysis and study to classify cerebellar new-growths according to their situation in the posterior cranial fossa. Such a classification has been adopted here, viz.: Group I—tumors which occupy a part or the whole of one hemisphere; Group II—median tumors which occupy the vermis, or the vermis and equal amounts of both hemispheres; Group III—recess tumors which occupy one cerebellopontine angle; and Group IV—median tumors which lie inferior to the cerebellum.

LITERATURE ON THE POSITION OF THE HEAD

A characteristic attitude of the head in patients with cerebellar new-growths has been described by Batten.¹ Of 6 cases investigated pathologically this position was noted in 3. The head was tilted so that the ear contralateral to the affected cerebellar hemisphere approximated the corresponding shoulder. There was also some rotation of the head, the chin being turned toward the side of the lesion. The fact that Batten discovered this position in some cases in which only internal hydrocephalus was found at necropsy indicates that he did not regard it as pathognomonic of cerebellar disease.

A certified case of cerebellar tumor in which the head was tilted toward the affected hemisphere has since been reported by Larnelle.¹¹

A characteristic inclination of the head to one side was noted by Gordon⁵ in a number of cases which he studied clinically and at necropsy. In several of these the position first assumed appeared reversed at subsequent periods of the disease.

Stewart and Holmes²⁰ found a more or less characteristic attitude in a number of cases of unilateral cerebellar and extracerebellar tumors. While sitting or standing the head was slightly flexed to the side of the

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lesion and rotated so that the chin was directed toward the opposite shoulder. As this position was occasionally found reversed and as it was met with in cases with lesions elsewhere in the brain, no important diagnostic or localizing importance was attached to it.

Oppenheim¹⁵ has encountered this sign in a number of patients with cerebellar tumors. Since contractures and paralyses of the neck muscles are usually absent he believes that the patient holds his head in that position which affords him the greatest relief from his discomforts. This has been Dr. Cushing's view. Any disturbance of postural sense which may exist as a result of the lesion plays a minor rôle. The attitude assumed by the head represents the position of greatest ease. In confirmation of this view he has drawn attention to the frequency with which passive flexion of the neck occasions pain.

Mills and Weisenburg¹³ in their kinematographic studies of asynergia noted a definite attitude of the head in only one case.

v. Beck² and Muck¹⁴ have drawn attention to the changes in intracranial circulation which result from turning the head on its vertical axis. When the chin is approximated to one shoulder the internal jugular vein on this side is compressed, while the opposite one is expanded. In controlling the bleeding from military wounds involving the mastoid region the latter has found this knowledge to be of considerable importance. Both v. Beck and Muck regard such an attitude of the head as characteristic for cerebellar and extracerebellar abscesses. In the presence of such a collection of foreign material more or less relief from headache is afforded by turning the chin to the side opposite to that of the abscess. This hastens the circulation in the homolateral internal jugular vein and accordingly lessens the venous congestion on the diseased side.

Backward retraction of the head, cerebellar fits (tetanus-like seizures), and the so-called cerebellar attitude, due to a gross exaggeration of the extensor muscles of the spine in the presence of tumors of the vermis, were first described by Hughlings Jackson,¹⁰ and since his communication in 1871 similar cases have been reported by others. Horsley⁹ observed opisthotonos attacks in a boy who was subsequently found to have a large new-growth occupying one cerebellar hemisphere. The cerebellar attitude was noted by Buzzard⁸ in a patient with a lesion confined to both dentate nuclei.

DATA ON THE POSITION ON THE HEAD

I. UNILATERAL HEMISPHERE TUMORS (Twenty-five Cases):

1. *Head Tilted Toward the Side of the Tumor.*—In 5 of the 25 cases in this group it was tilted slightly; in a sixth the attitude was

more marked. One case showed a slight rotation of the head, the chin being directed toward the side contralateral to the tumor.

2. *Head Tilted Away from the Side of the Tumor.*—Of 4 such cases 1 was tilted only slightly. Some turning of the chin toward the side of the tumor was noted in 2 cases.

3. *Head in No Unusual Attitude.*—Fifteen cases showed nothing characteristic about the position of the head.

II. TUMORS INVOLVING THE VERMIS OR THE VERMIS AND EQUAL AMOUNTS OF BOTH HEMISPHERES (Thirteen Cases):

1. *Head Tilted to One Side.*—In 6 of the 13 cases in this group there was some tilt toward one side. Four of these had slight rotation of the chin in the direction opposite to that in which the head was tilted.

2. *Head in No Unusual Position.*—Seven cases showed nothing characteristic.

III. UNILATERAL CEREBELLOPONTINE TUMORS (Seventeen Cases):

1. *Head Tilted Toward the Side of the Tumor.*—Of the 17 cases in this group 3 showed a slight and 1 a more marked tilt of the head toward the side of the tumor. The chin was turned toward the opposite shoulder in 4. In 1 of the latter, however, the head was not tilted in either direction.

2. *Head in No Unusual Attitude.*—There was nothing characteristic about the position of the head in 12 of the 17 cases.

IV. MEDIAN, INFERIOR, EXTRACEREBELLAR TUMORS (Three Cases):

1. *Head Tilted to One Side.*—In 1 of the 3 cases in this group the head was tilted slightly to one side.

2. *Head Tilted Forward.*—One case showed a marked, persisting, forward inclination of the head on the chest.

3. *Head in No Unusual Attitude.*—The head was carried in a normal position in one case.

SUMMARY.—Thus 35 of the 58 cases in which the attitude of the head was studied showed no unusual position of the head. There were 42 cases with unilateral tumors. In 10 the head was tilted toward the lesion; in 4 it was tilted toward the side opposite to the lesion; and in 28 no tilting to either side was noted.

TUMORS LYING ANTERIOR TO THE CEREBELLUM

I. *Unilateral, Solitary, Parietal Lobe Tumors.*—Of 13 cases no characteristic position of the head was noted in any of them.

II. *Unilateral, Solitary, Temporal Lobe Tumors.*—No characteristic attitude of the head was noted in 8 cases.

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III. *Unilateral, Solitary, Temporoparietal Tumors*.—One case. The head here was tilted slightly toward the side of the new-growth.

IV. *Unilateral, Solitary, Occipital Lobe Tumors*.—One case. No unusual position of the head noted.

V. *Unilateral, Solitary, Frontal Lobe Tumors*.—Two cases. Neither showed any characteristic attitude of the head.

VI. *Extradural Tumor at Foramen Magnum*.—One case. Head held in no unusual position.

VII. *Pontine New-growths—Solitary*.—Three cases. In 1 the head was tilted slightly to one side with some rotation of the chin toward the opposite shoulder. Two cases showed neither rotation nor tilt.

VIII. *Solitary Tumors Involving Basal Ganglia*.—Three cases. No unusual position was found in 2 of these. One held his head tilted slightly toward the side of the tumor while sitting in a chair. While walking, however, the tilt was in the opposite direction.

IX. *Interpeduncular (Pituitary) New-growths*.—Eleven cases. No characteristic position was noted in any of them.

BACKWARD RETRACTION OF THE HEAD

In a series of 58 cases of cerebellar and extracerebellar tumor there were 8 which showed this symptom. The retraction occurred only during the periods of suboccipital headache in every case. At such times flexion of the neck was painful. Holding the head forward as in writing would precipitate an attack of suboccipital pain in one patient. A ninth obtained relief from suboccipital distress by throwing the head backward. The lesion involved one cerebellar hemisphere in 6 of these, the vermis and one hemisphere in 1, and the cerebellopontine angle in 2. Strange to say, in one subject the greatest relief was afforded by keeping the head flexed forward on the chest. The tumor here involved one lateral lobe.

True opisthotonos attacks have occasionally been observed but they were featured in the histories of two patients. In both the seizures were marked by severe occipital pains, extreme retraction of the head, a backward curving of the spine, and a sense of impending death. Periods of rigidity described by Hughlings Jackson were observed in each subject—in one, enduring frequently for hours. Operation with subsequent necropsy demonstrated an extensive glioma in both. The new-growth involved the vermis and part of the left hemisphere in one and the anterior portions of the vermis and both lateral lobes in the other.

No backward retraction of the head was noted in any of the cases with tumors lying anterior to the cerebellum.

ATROPHY OF THE OCCIPITAL BONE AND LOCAL TENDERNESS

Occipital tenderness in cases with new-growths in the posterior cranial fossa is usually ascribed to atrophy or osteoporosis of the subjacent bone. The data resulting from comparisons of clinical and operative findings in many of the patients reported here, however, have not harmonized satisfactorily with such a view. In order to obtain a more comprehensive idea of the possible bearing of one of these factors on the other a series of cases were selected in which the condition of the occipital bone had been specifically described in the operative note. The relations found in this certified group are indicated by the following analysis.

I. *Unilateral hemisphere tumors* (19 cases):

Bilateral tenderness with no noteworthy thinning of the occipital bone, 1 case.

Bilateral tenderness with bilateral thinning of the occipital bone, 1 case.

Bilateral tenderness with homolateral (as regards the site of the tumor) thinning, 1 case.

Homolateral tenderness with bilateral thinning of the bone, 1 case.

No tenderness and no thinning of the occipital bone, 7 cases.

No tenderness with bilateral thinning of the occipital bone, 7 cases.

No tenderness with homolateral thinning of the occipital bone, 1 case.

II. *Tumors involving vermis or vermis and equal amounts of both hemispheres* (7 cases):

Bilateral tenderness with bilateral thinning of the occipital bone, 1 case.

Unilateral tenderness with no thinning of the occipital bone, 1 case.

No tenderness and no thinning of the occipital bone, 2 cases.

No tenderness with bilateral thinning of the occipital bone, 3 cases.

III. *Unilateral cerebellopontine tumors* (13 cases):

Bilateral tenderness with no thinning of the occipital bone, 3 cases.

Homolateral tenderness with bilateral thinning of the occipital bone, 1 case.

Contralateral tenderness with bilateral, especially homolateral, thinning, 1 case.

No tenderness or thinning of the occipital bone, 5 cases.

No tenderness with bilateral thinning of the occipital bone, 1 case.

No tenderness with unilateral thinning of the occipital bone, 1 case.

IV. *Median, inferior, extracerebellar tumors* (3 cases):

Unilateral tenderness with no thinning of the occipital bone, 2 cases.

Tenderness and thinning of the occipital bone, 1 case.

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LITERATURE ON SUBOCCIPITAL DISCOMFORT

Headache, as is well known, is practically always present at some stage in patients with cerebellar and extracerebellar new-growths, due usually to the fact that secondary internal hydrocephalus appears as an early complication. Redlich,¹⁹ Oppenheim¹⁰ and others found it to be chiefly occipital in such cases. The former noted that it is occasionally more marked on the side of the tumor and may take the form of a severe occipital neuralgia. According to Stewart and Holmes²⁰ the situation of the headache is often suggestive of the seat of the disease.

Stiffness of the neck muscles and pain in one or both sides, when the head is bent forward or turned to either side, frequently accompanies the other discomforts of cerebellar new-growths. The importance of stiffness of the neck in cerebellar abscess and in epidural abscess of the posterior cranial fossa without meningitis has been emphasized by Friedenberg, Okada¹² and others. Dr. Cushing has found that pain elicited by passively flexing the head is often a valuable diagnostic guide in patients with subtentorial tumors. Like the headache, however, both of these signs may be present with growths situated elsewhere in the brain. Oppenheim¹⁷ observed a stiffness of the neck in cases of frontal lobe tumor. Finkelburg⁴ found stiffness of the neck muscles and pain in the occiput and neck in cases with tumors of the interpeduncular region.

Occipital tenderness has been noted in many cases of cerebellar tumor. Redlich¹⁹ occasionally found a distinct local tenderness on percussion over the side of the tumor. In the cases studied by Stewart and Holmes²⁰ the majority experienced considerable discomfort when pressure was made over this region. Generally it was greater on the side corresponding to the disease. Taken collectively with other features of the history and examination, Dr. Cushing regards tenderness in the suboccipital region as a very suggestive symptom of a subtentorial new-growth. Oppenheim¹⁸ believes that in extracerebellar tumors this sign is of value only where there is considerable increased intracranial pressure with local osteoporosis.

DATA ON SUBOCCIPITAL DISCOMFORTS

I. UNILATERAL HEMISPHERE TUMORS (Twenty-six Cases):

1. *No Suboccipital Discomforts*.—Five of the 26 cases in this group had no suboccipital headache, pain, tenderness or stiffness of the neck muscles.

2. *More Suboccipital Discomfort on the Side of the Tumor*.—Five cases. Three had more tenderness, 4 had more suboccipital headache

or neuralgic pains, and 2 had more stiffness and soreness of the neck muscles (especially on turning the head from side to side) on the side homolateral to the lesion.

3. *More Suboccipital Discomfort on the Side Contralateral to the Tumor.*—Four cases. One had slight tenderness, 2 had more headache and 3 more stiffness or soreness of the neck muscles.

4. *Bilateral Suboccipital Discomfort.*—Twelve cases. Three had some tenderness, nine had some suboccipital headache or pain, and 6 had some stiffness or soreness of the neck muscles—equally marked on the two sides.

II. TUMORS INVOLVING THE VERMIS OR THE VERMIS AND EQUAL AMOUNTS OF BOTH HEMISPHERES (Thirteen Cases):

1. *No Suboccipital Discomfort.*—Five cases. No local tenderness, headache, pain, or stiffness and soreness of the neck muscles.

2. *Unilateral Suboccipital Discomfort.*—Three cases. Two had tenderness, 1 had headaches, and 1 had more stiffness and soreness of the neck muscles (on twisting the head) more marked on one side.

3. *Bilateral Suboccipital Discomfort.*—Five cases. In 3 there was local tenderness; in 4, headaches; and in 1, stiffness of the neck muscles equally marked on the two sides.

III. UNILATERAL CEREBELLOPONTINE TUMORS (Seventeen Cases):

1. *No Suboccipital Discomfort.*—Five cases. No one of these experienced any local tenderness, suboccipital headaches or pain, or stiffness and soreness of the neck muscles.

2. *More Suboccipital Discomfort on the Side of the Tumor.*—Five cases. Two had more tenderness, 5 had more headache or pain on this side, and 1 had more stiffness of the neck muscles.

3. *More Suboccipital Discomfort on the Side Contralateral to the Tumor.*—Two cases. Both had more tenderness and more headaches on this side. One also experienced more stiffness of the contralateral neck muscles.

4. *Bilateral Suboccipital Discomfort.*—Five cases. Three had local pain or headache equally marked on the two sides.

IV. MEDIAN, INFERIOR, EXTRACEREBELLAR TUMORS (Three Cases):

1. *Unilateral Suboccipital Discomfort.*—Two cases. Both of these had local tenderness and stiff neck muscles, and one also complained of headaches, more marked on one side of the occiput.

2. *Bilateral Suboccipital Discomfort.*—One case. Stiffness of the neck muscles and suboccipital pain were equally marked on the two sides.

SUMMARY.—Thus only 15 out of the 59 cases failed to have sub-

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occipital discomfort. Forty-three of the 59 had unilateral tumors. Of these 10 had more suboccipital discomfort on the side of the lesion, 6 had more on the contralateral side and 17 experienced equal discomfort on the two sides.

TUMORS LYING ANTERIOR TO THE CEREBELLUM

I. *Unilateral, Solitary, Parietal Lobe Tumors*.—Thirteen cases. Ten of these had no suboccipital discomforts. Two experienced some discomfort on the side homolateral to the tumor. Of the latter both had headache and pain, one had stiffness of the neck muscles and both had suboccipital tenderness.

II. *Unilateral, Solitary, Temporal Lobe Tumors*.—Eight cases. Six had no suboccipital discomfort. Of the 2 which experienced some, 1 had stiffness of the neck, both had local tenderness, and both had some suboccipital headache or pain. The discomfort in these 2 cases was experienced more on the side homolateral to the tumor.

III. *Unilateral, Temporoparietal Tumor*.—One case. There was slight suboccipital tenderness and some suboccipital headache on the side of the new-growth.

IV. *Unilateral, Occipital Lobe Tumor*.—One case. There was slight suboccipital pain and stiffness of the neck muscles on the side of the tumor.

V. *Unilateral, Solitary, Frontal Lobe Tumors*.—Two cases. Neither had suboccipital headaches, pain, tenderness or stiff neck muscles.

VI. *Extradural, New-growth at Foramen Magnum*.—One case. Some bilateral tenderness and stiffness of the neck muscles.

VII. *Pontine New-growths—Solitary*.—Three cases. One had no suboccipital discomforts. Two complained of some, more marked in each case, on one side of the occiput—tenderness and headache.

VIII. *Solitary Tumors Involving the Basal Ganglia*.—Three cases. One had some suboccipital headache, equally marked on the two sides. Two experienced suboccipital discomforts chiefly on the side of the lesion—both from stiffness of the neck muscles, and one from tenderness and headache.

IX. *Interpeduncular (Pituitary) New-growths*.—Eleven cases. One complained of some bilateral suboccipital headache. The other 10 cases experienced no suboccipital discomforts.

SUMMARY AND CONCLUSIONS

Of 58 certified cases of cerebellar and extracerebellar tumor an unusual attitude of the head—tilted so that the ear approximated one

shoulder, or both—was found in 23. In the majority of these the change in position was slight. Of 43 certified cases of tumor lying anterior to the cerebellum only 3 showed any tilt or rotation of the head. The unusual attitude in these 3 cases was scarcely noticeable. About 40 per cent., then, of the cases with cerebellar tumor showed some change in the position of the head while only about 7 per cent. of the cases with tumors anterior to the cerebellum showed any unusual attitude.

These findings indicate that a tilt or rotation of the head in a patient with symptoms pointing toward an intracranial tumor is suggestive of a subtentorial new-growth. Such an attitude, however, has no additional significance in localizing the lesion in one or the other side of the posterior cranial fossa.

Backward retraction of the head was a feature in 8 of the 60 cases of cerebellar and extracerebellar tumor. Typical opisthotonos attacks appeared in 2 of these. A similar position was noted in none of the cases with tumors lying anterior to the cerebellum. Backward retraction of the head, then, is characteristic of new-growths situated below the tentorium.

While atrophy or osteoporosis of the subjacent bone may occasion occipital tenderness in certain cases, comparisons of the clinical and operative findings in this series of cases have shown no consistent relations to exist between the two.

Of 59 certified cases of cerebellar and extracerebellar tumor some form of suboccipital discomfort was present in 44, about 75 per cent. Tenderness in the subocciput was found in 21, 36 per cent. Suboccipital headache or pain was complained of in 33, 56 per cent. There was more or less soreness or stiffness of the neck muscles in 18, nearly 31 per cent. Accordingly, headache or pain is the most frequent of the suboccipital discomforts.

Of 43 certified cases with tumors lying anterior to the cerebellum some degree of suboccipital discomfort was found in 14, approximately 33 per cent. Suboccipital tenderness was present in 8, nearly 19 per cent. Suboccipital headache or pain appeared in 10, about 23 per cent. Soreness or stiffness of the neck muscles was complained of in 6, 14 per cent. As a rule the occipital discomforts were much less intense in the cases with tumors situated anterior to the cerebellum than in those with subtentorial new-growths.

Taking the series as a whole, no consistent relation has been found between the part of the posterior cranial fossa occupied by the tumor and the site of the discomfort. When unilateral suboccipital discomfort

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is present, however, it is slightly suggestive of the side of the new-growth.

These findings indicate that suboccipital discomforts are present more than twice as often in patients with subtentorial new-growths as in those with tumors situated elsewhere in the brain; and, though they afford only slight assistance in localizing the lesion in one or the other side of the posterior cranial fossa, they nevertheless rank with asynergy (limb ataxia, staggering gait, etc.) as the most important indications of a subtentorial localization of intracranial new-growths.

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CALCULI IN THE SUBMAXILLARY GLAND AND WHARTON'S DUCT*

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THERE are few surgical conditions in which such immediate and considerable relief of annoying symptoms can be obtained by such a comparatively minor operation as is the case with stone in the submaxillary salivary gland and duct. The writer has operated in six such cases under novocaine anæsthesia, removing the calculus through the mouth. The condition is not a very common one. I seem to have been rather unusually fortunate in seeing these cases, for in conversation with acquaintances of equal surgical experience, none have recalled seeing more than one or two. In the following cases the diagnosis has usually been overlooked by one or more physicians. This is explained in part by the infrequency of the condition and in part by the failure of the examiners to digitally explore the floor of the mouth.

CASE I.—The history of the first case was unusually interesting. A man came to me after a year's treatment by various physicians, complaining of pain and swelling under the jaw. At first, examination failed to reveal anything amiss. He then took from his pocket a piece of cheese which he had brought for the purpose and began to eat it, stating that cheese would usually bring on the pain and swelling. On this occasion he was not successful and was about to leave the office with the advice to call again when the swelling was present, when he turned at the door and said, "I believe it is coming." Within a few minutes there appeared a distinct swelling beneath the jaw and a ridge in the floor of the mouth following the course of Wharton's duct. A white speck was visible at the caruncula sublingualis. The duct was grasped with the thumb forceps just behind the caruncula and with scissors a nick was made in the duct and a calculus liberated in size not larger than a pin's head. The patient has had no trouble since.

The other cases may be briefly described as follows:

CASE II.—A very gouty, adult woman was treated for abscess of the jaw. This was poulticed for a time, but finally the abscess broke in the mouth. The abscess having broken, she was told that the trouble would subside. I saw her first several weeks later with a purulent discharge in the mouth and an induration in the

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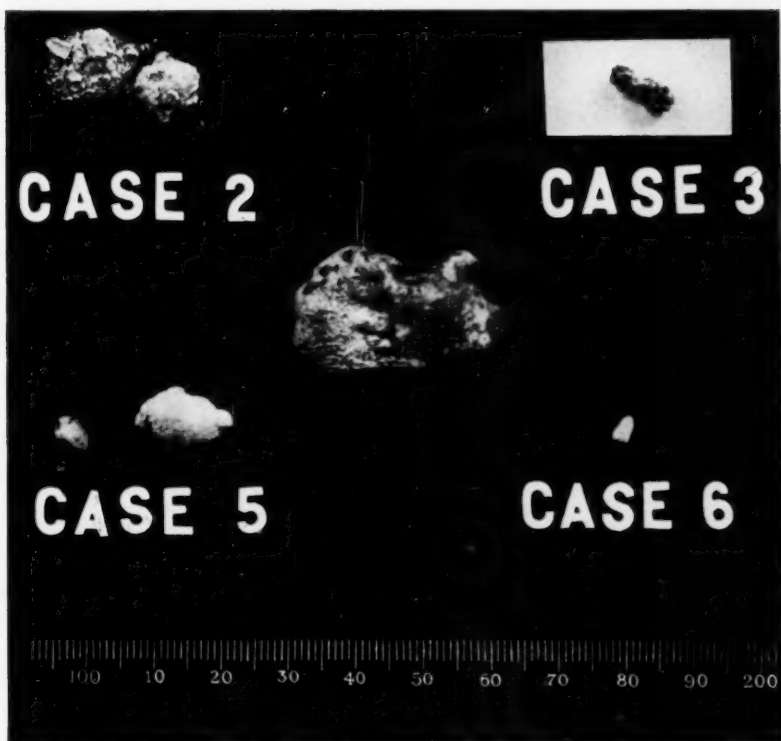
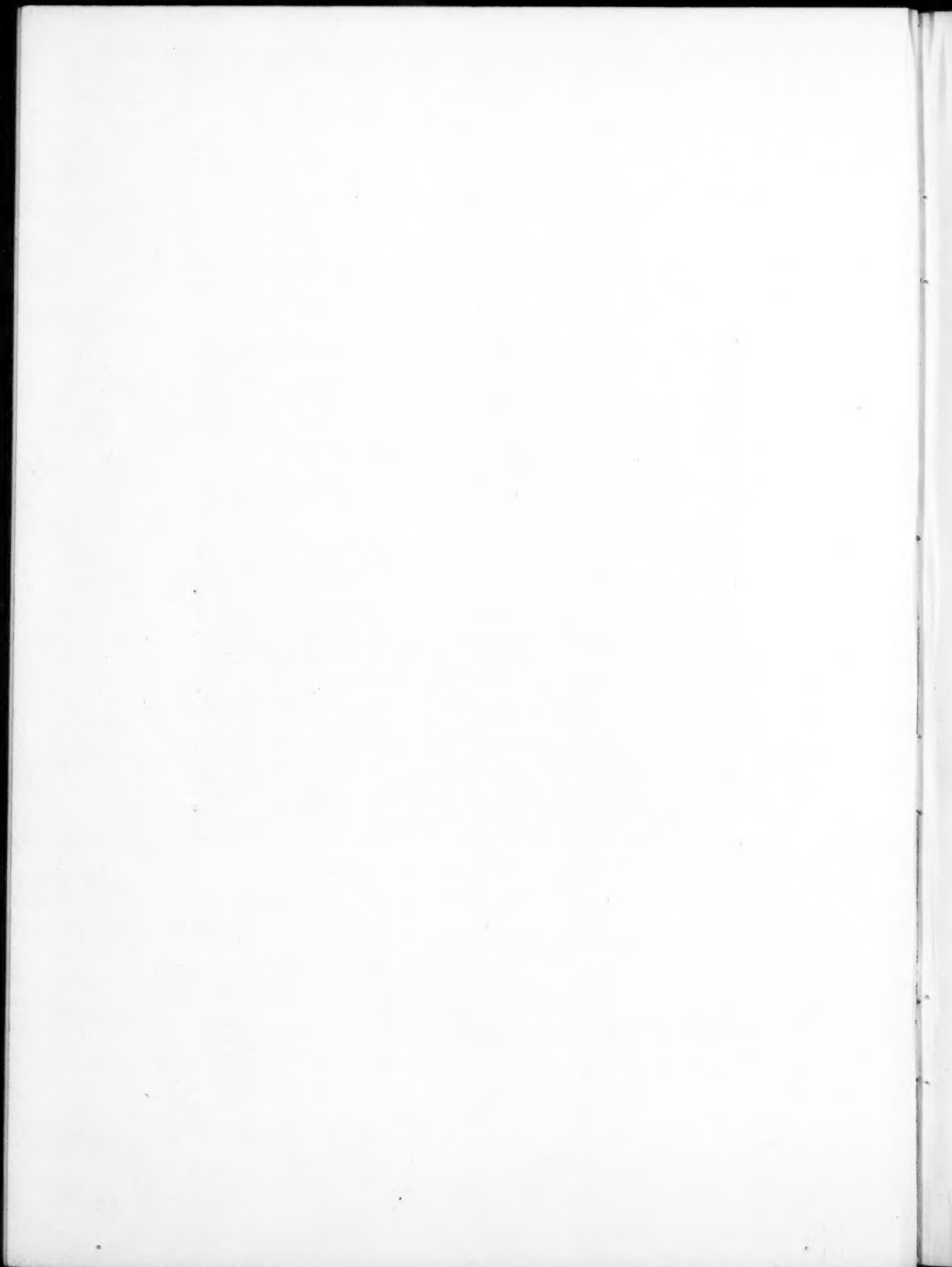


FIG. 1.—Stones from Wharton's duct. The large central stone is from a case of Dr. Richard Derby.



CALCULI IN THE SUBMAXILLARY GLAND

floor of the affected side of the mouth. Palpation easily revealed the stone about as far back as the first molar tooth. The stone was removed by novocainizing the vicinity and incising through the mucosa of the floor of the mouth. The stone was larger than a pea.

CASE III.—A young woman presented herself with an elongated stone resembling in size and shape a grain of wheat. It produced intermittent obstruction to the duct and could readily be dislocated back and forth. The duct was opened near its orifice and the stone readily removed through the opening.

CASE IV.—A Porto Rican, almost immediately on arriving in New York, was taken with a chill and high temperature accompanied by pain and swelling in the submaxillary gland region. Under local anæsthesia the duct was incised and a slightly elongated, pinhead-sized stone was removed. The symptoms, however, did not subside. Pain and swelling continued and, several days later, another stone like the first was discovered and removed. Recovery followed.

CASE V.—A man past middle life had had inflammation in the floor of the mouth and, at intervals, a sinus discharging pus into the mouth. He was rendered uncomfortable but not unable to attend to his work. The tissues at the floor of the mouth felt brawny and a stone could be indistinctly palpated through the inflamed tissue. The stone was located not far from the caruncula sublingualis. On incision, a stone nearly the size of a pea was removed. There was a discharge of several drachms of pus from the dilated duct. A probe was inserted for more than an inch and came upon another stone firmly impacted in this situation. The duct was incised more liberally and stretched by opening a clamp within it. It was not possible, however, to dislodge the stone until the passage had been dilated by means of the little finger. The stone was then grasped with forceps and removed. When seen a month later, all induration had disappeared.

CASE VI.—This patient gave a history of intermittent inflammation and abscess in the submaxillary region, extending over seven years. He entered the ward of St. Luke's Hospital with temperature and a submaxillary phlegmon. An incision was made below the jaw into the indurated tissue but very little pus was evacuated. Several days later, when he was first examined by me, the swelling had not entirely disappeared. I suspected a calculus and under cocaine anæsthesia split and probed the duct, but was unable to find a stone. The patient was soon discharged from the hospital and a week later returned to the hospital with a stone which had been spontaneously ejected from the wound in the floor of the mouth.

REMARKS.—Except that one patient was gouty, there has been nothing in the history to point to an etiological factor in the above cases. Three of the patients were about thirty years of age, the others between fifty and sixty. Four were men and two women.

Symptomatically, the cases may be divided as follows:

(A) Patients in whom, at intervals, especially at meals, there is pain and swelling under the jaw but no sign of inflammation. In these cases, the stone is small and acts as a ball valve.

(B) With or without a history of intermittent swelling in this region, there suddenly appears a painful swelling with high fever, not unlike mumps. This may soon subside or go to the third condition.

(C) A hard swelling forms under the jaw and a ligneous œdema fixes the tissues of the floor of the mouth on the affected side. If pus forms, it is more likely to evacuate itself into the mouth than externally. Temperature subsides when the pus is evacuated but a variable amount of induration may persist indefinitely. A sinus discharging pus may remain for months.

Diagnosis.—This is made partly from the history. Swelling of the gland at meal times or a persistent swelling under the jaw and in the floor of the mouth should make one suspect the diagnosis of submaxillary calculus. The larger stones—that is, the size of a pea—can be palpated bimanually even in the presence of considerable œdema. The pinhead-sized stones can be felt, or perhaps seen, when they slip forward into the anterior part of Wharton's duct.

Treatment.—The stones in these six cases have all been removed through the floor of the mouth. In some cases, a sinus has been dilated with instruments or a finger; in other cases the duct has been incised over the stone. In the cases where a sinus exists and there has been prolonged suppuration, one would fear that cicatrization might produce a stricture of the duct and keep up the infection in the gland. I recall telling one patient that removal of the gland might prove necessary, but it never has been. Relief has been prompt and permanent. One should be on the lookout for multiple stones, a condition present in two of the above cases. Unless the calculus is found and removed, incisions in the mouth or externally will be followed by but partial and temporary relief. In Case V recurrent attacks extended over seven years.

TUBERCULOSIS OF THE TONGUE*

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As deduced from autopsy reports and clinical records, tuberculosis of the tongue is infrequent. Willigk,¹ in 1317 necropsies of tuberculous subjects, found tuberculous lesions in the tongue twice only; Fowler,² in 382 autopsies, found it four times; Fischer,³ three times in 1500; Chiari,⁴ twelve times in 625; and Adami,⁵ in 417 autopsies of tuberculous cases, found none.

In statistics on pulmonary tuberculous lesions in German Sanatoria, Hamel⁶ records one single case of tuberculosis of the tongue in 12,369 subjects. Von Ruck⁷ gives the frequency of 0.38 per cent. in tuberculous subjects deduced from a material of 5000 patients studied in Winyah Sanatorium.

Literature covering the contributions to the casuistics collected by Dalla Vedova⁸ previous to 1906 and by me from January 1, 1901, to October 20, 1915, comprises about 250 cases of primary and secondary tuberculosis of the tongue, some of which are recorded without anatomoclinical details. Blancard's⁹ article reporting three interesting cases is the latest contribution.

The reason of the relative infrequency of tuberculous lesions of the tongue, an organ so near the source of infection, is probably due to two factors: (1) To the particular structure of the lingual mucosa which resists the direct penetration of the *Bacillus tuberculosis*; and (2) to the natural resistance which all striated muscles present to the lodgement of the bacilli. This resistance has been attributed by certain writers to antibacterial and antitoxic action, accentuated or reinforced by glycogen. It acts against microorganisms in general and against the *Bacillus tuberculosis* in particular, as was demonstrated *in vitro* by Teissier.¹⁰ It has also been ascribed to the continuous fibrillation which obstructs the attack of the bacilli. Nevertheless, though the facts are indisputable its fundamental reason remains obscure.

The larger proportion of these cases occur between the twentieth and fiftieth year; rarely above the latter age, though the case reported by Zintsmaster¹¹ was in the eightieth year. One case, that of Reimann,¹²

* Submitted for publication October 28, 1915.

occurred at nineteen years. None are recorded as having occurred in infancy, the age in which tuberculous lesions are so frequent and widespread.

These considerations seem to justify the deduction that the tuberculous process in the tongue is assisted by the causes common to middle age, such as trauma of the mucosa by the stem of a pipe, by carious teeth, by toxic glossitis, etc., and these causes, more frequent among men, explain the greater frequency of tuberculosis of the tongue among men. Chvostek's¹³ statistics show one woman to every four men; Schliferowitsch's¹⁴ show one in five cases; Delavan's¹⁵ show one in twenty-three.

The routes by which tuberculosis localizes itself in the tongue, though theoretic, are reducible to certain organs: (1) by the blood-vessels; (2) by the lymphatics; (3) by direct infection; and (4) by extension. Practically these routes cannot always be determined and the frequency of infection by a given route can be determined with scientific precision only with difficulty. Also, in cases in which the lesion of the tongue represents the late secondary localization of a primary bronchopulmonary tuberculous process it is always dubious to affirm or exclude by which of these routes, whether by the blood-vessels, the lymphatics or by direct inoculation by way of the excretion, the bacilli have reached the lingual focus. All three routes are possible, but no one character of the clinical course or of the microscopic findings permits a sure differentiation. The fourth route which I have stated as theoretically possible, that of the extension to the tongue by continuity of a tuberculous process in a neighboring region, I have not found recorded in the literature.

The tongue is one of the first organs which can come into contact with the infectious elements by way of the air or by the passage of food, and, by reason of the diminished vitality of the integument in circumscribed areas, determined by the many traumatic causes mentioned, can become primarily the seat of a tuberculous lesion. The theoretical possibility of a primary tuberculosis of the tongue is practically confirmed by two cases described by Clarke¹⁶ and by Schliferowitsch.¹⁴ These were operated on for tuberculous ulcers of the tongue and died from other causes. Tuberculous lesions were not found in other organs. Literature records¹⁷ many other cases of "primary" tuberculosis of the tongue, but this term should be accepted in a clinical sense only, since the cases were not controlled by autopsy.

In the majority of cases tuberculosis of the tongue has a localiza-

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tion secondary to a tuberculous process in other parts of the organism, *e.g.*, in the anus (Burquoy¹⁸) and in the epididymis (Weber¹⁹).

The anatomical forms which tuberculosis of the tongue may assume do not represent a distinct anatomical entity, but often diverse forms of the same evolutionary process or varying anatomical aspects from case to case, and from region to region, according to the virulence of the bacilli and the reaction and local resistance of the tissues. For this reason they have a clinical rather than an anatomical interest. Whatever may be the final anatomico-clinical form of tuberculosis of the tongue, the beginning is always characterized by specific connective tissue, new formation of tuberculous nodules, which may be localized separately in the dermis of the mucosa or in the lingual parenchyma.

From this distinct initial localization of the tuberculous process may originate two clinically different types. The first, namely, the connective tuberculous new formation, if in the lingual dermis, assumes characteristics approximating cutaneous lupus. It presents itself initially as a plaque of grey color somewhat elevated above the surrounding mucosa without inflammatory reactions, and hard to the touch. It is formed by the grouping of small miliary nodules which, if they preserve the sclerotic form, are spoken of as glossodermatitis tuberculo-fibrosa. Should these ulcerate, they are called glossodermatitis tuberculo-ulcerosa. These two distinct forms of lingual lupus through the possible transition to another, sometimes assume aspects with difficulty referable to a fixed type. The lupous lesions of the tongue are always accompanied by lupous lesions of the buccal mucosa, of the nose, or of the skin of the face, and represent a complication not relatively rare. Licht Institute reported over 2000 patients affected by lupus vulgaris of the face in whom lingual lupus was noted only fifteen times.

When, on the other hand, the tuberculous elements affect primarily the parenchyma of the tongue (or rather the intramuscular connective tissues of the tongue, since the question arises whether a true primary tuberculous myositis ever exists), they may coalesce in such a way as to constitute a single nodule—nodular tuberculosis, confluent tuberculosis, granuloma tuberculare—or, if they may be disseminated in various regions—disseminated miliary tuberculosis, tuberculosis nodulare multiple or gummatous.

Each form, though the confluent more readily than the disseminated, may maintain its anatomic individuality for months and years and simulate a neoplastic lesion or the localization of tertiary lues. It tends in the early stage to caseous necrosis, becoming fluctuating (cold abscess of the tongue) and opening to the surface with the formation of

a large ulcer or a fistulous opening. The typical tuberculous ulcer has irregular margins, sinuous, soft and reddened, with a soft yellow base. It is surrounded by granulations easily bleeding. It may appear in any region of the tongue but with more frequency on the margins and tip. The adenitis which accompanies it is often bilateral and slightly painful to pressure.

From a review of the clinical history one deduces that the persistence of the two clinical individualities, the nodular form and the ulcerative form, is influenced by the condition and the course which the tuberculous infection assumes in other parts of the body, of which the lingual lesion is generally a secondary localization. The form which for most of the time maintains the nodular type, single or multiple, accompanies a tuberculous infection, generally of the lung, with a slow course, not destructive, or is an indirect primary form. The forms which tend rapidly to caseous necrosis are habitually concomitant with and secondary to deep and destructive lesions of other organs.

Literature records still another form of tuberculosis of the tongue of a verrucose (Francois-Dainville²⁰) or papillomatous type (Danlos and Levy-Frankel²¹), so-called from the aspect which the mucosa may assume when its papillæ become infiltrated by a tuberculous granuloma of the lymphoid type. There has never been described in the tongue the type of inflammatory hypertrophic tuberculosis of a pseudoneoplastic character found in the smooth musculature of the pylorus, of the cæcum and in striated muscles.

The result of the search for the bacillus of Koch in tuberculous glossitis is usually positive; though sometimes in cases of undoubted tuberculosis of the tongue it may be negative (Dalla Vedova,⁸ Campbell,²² Trimble,¹⁷ Schliferowitsch¹⁴). In order to exclude the presence of the specific bacteria in the affected tissues it is necessary to supplement the biologic test by the use of both Ziehl-Neelson's and Gram's methods of staining. We know, in fact, following the works of Mircoli,²³ Much,²⁴ Constantini,²⁵ etc., that contemporaneously with the morphologic variability of the tuberculosis bacillus its chemical properties and staining reactions vary also. There exists, indeed, a species of tuberculosis bacillus of the typical form of rod which does not stain by Ziehl's method but does stain by the prolonged method of Gram; and a granular form which has a chromatin affinity exclusively for the Gram stain.

The symptoms of lingual tuberculosis vary following the anatomical form which it assumes and following its stage of evolution. The char-

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acteristics of tuberculous infection in all the organs, the absence of subjective disturbance in the initial stage of the lesion, marks the beginning of tuberculosis of the tongue which develops slowly and almost painlessly until it assumes the ulcerative form. At this stage there is an abundant salivation (ptyalism) from the specific reflex secretory stimuli pertaining to the ulcerated surface and mild spontaneous tenderness through the diffusion of the inflammatory process to the lymphatic sheaths of the nerve filaments and through the pain due to the passage of food. Such pain, together with the inflammatory condition, often limits the normal mobility of the tongue on account of the facility with which it is complicated by secondary infection, accompanied early by a somewhat painful regional adenopathy. This adenopathy in general is absent in the closed, non-ulcerative form of lingual tuberculosis.

Diagnosis.—The diagnosis in the initial stage of the process of evolution presents generally great difficulty when the attempt at diagnosis is limited to the direct physical findings. A review of the literature in this connection impresses one with the frequency with which tuberculosis of the tongue is confused with epitheliomatous neoplasm or with tertiary lues. The first, most common, diagnostic error in this connection has often led to the amputation of the tongue and to the accompanying complementary operations of the neck, as in cases reported by Albert,²⁶ Hansemann,²⁷ Bull,²⁸ Dalla Vedova,⁸ Euteneuer.²⁹ The second diagnostic error leads to mercurial treatment which has been actually employed in 180 reported cases.

Lupus of the tongue, in whatever aspect it presents itself, is not difficult to diagnose. It may be confused with the papillary or ulcerative lesions of lues; but the generic criteria which serve to differentiate the two lesions in any organ, anamnesia, the trial of specific serous methods of diagnosis, therapy, etc., or, better, the microscopic examination of the excised tissue, will serve to make the differentiation.

All the other forms of lingual tuberculosis present serious difficulties unless recourse be had to microscopic examination. The nodular form of intralingual tuberculosis, confluent or disseminated, in the beginning is quiet, without pain, not accompanied by a swelling of regional glands and is simulated more frequently by the gummatous lesions of lues. To exclude the syphilitic affections, it should be noted that these have a predilection for the base of the tongue, while tuberculosis elects the tip; they are less painful than tuberculous granulomata and in a few weeks ulcerate. Again, one should use the criteria mentioned above in the differentiation of the lupous form from syphilis of the tongue.

This nodular form of lingual tuberculosis may also be confused with actinomycosis, rarely with fibroma, lipoma or sarcoma. Criteria of approximate differentiation can be found if we remember the characteristics noted as pertaining to each pathologic form. Sure criteria are difficult to find if we do not employ the direct examination of the tissue of the tumor.

The ulcerative form of lingual tuberculosis, especially if the lesion is primary and alone, assumes great surgical interest from its being easily confused with cancerous ulcer, because this is of much greater frequency than the first and because both have a predilection for the same age, the same sex, and the same lingual region. In typical forms the two ulcers can often be differentiated by a single direct examination; but often the tuberculous ulcer does not present the characteristics which I have recorded, but occurs with margins and with the base moderately indurated by inflammatory infiltration (Zintsmaster,¹¹ Dally,³⁰ etc.), spontaneously painful from the diffusion of the inflammatory process in the lymphatics and the nerve filaments. In such a case it is obvious how an error may easily take place because the differential characteristics, described for the two ulcers and for those omitted because they are intuitive, have substantially an academic value, not a practical one.

It is therefore not prudent that the diagnosis of ulcerous lesions of the tongue should be determined by a single method or by the clinical signs, but should be founded on an accurate histobiologic test. The removal of tissue for the histobiologic test and for the inoculation of guinea-pigs is the diagnostic means most certain and is the method of election to differentiate the neoplastic lesion of the tongue from tuberculosis. At least the histologic examination of the base of the ulcer in frozen sections during the operation should be done, thus sometimes preventing greatly destructive and useless intervention.

Prognosis.—The prognosis is favorable when the tuberculosis of the tongue presents itself as a primary and unique lesion; less so when it is primary but has a multiple localization. It is generally unfavorable when the lingual lesion presents itself as a late localization and secondary as a bronchopulmonary process. In such cases it assumes the gravity which the tuberculous process has in the principal focus and does not follow the evolution.

Treatment.—The therapy of election, avoided by previous authors, has been operative when the tuberculous lesion of the tongue was single and circumscribed. In the multiple and diffuse lesions the treatment

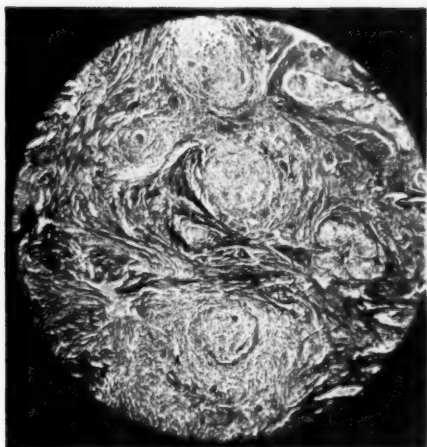


FIG. 1.—Case IV. Tuberculosis of the tongue—multiple tubercles forming a single nodule. Section stained with Weigert-v. Gieson stain. Photomicrograph (80 diam.) showing four typical miliary tubercles, forming one nodule, situated in the muscular stratum, surrounded by dense connective tissue.

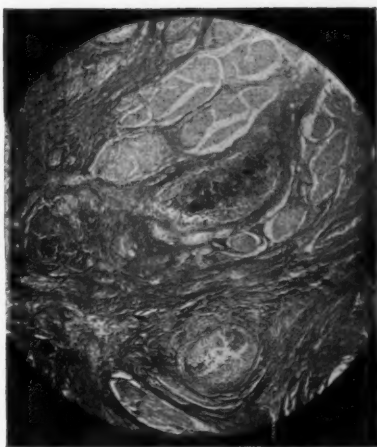


FIG. 2.—Case IV. Tuberculosis of the tongue—multiple tubercles forming a single nodule. Section stained with Weigert-v. Gieson stain. Photomicrograph (90 diam.) showing a typical tubercle and a nodule, containing lymphoid cells only, side by side; the lymphoid cells may also be seen invading the connective tissue between the muscle-bundles.



FIG. 3.—Case V. Tuberculosis of the tongue—ulcerating stage. Section stained with Weigert-v. Gieson stain. Photomicrograph (100 diam.) showing the margin of the ulcer and containing small-cell infiltration and typical nodular lesions.



FIG. 4.—Case V. Stained with Unna-Pappenheim stain. Photomicrograph (220 diam.) showing the invasion of the papillary tunica propria by small-cell infiltration and giant cells.

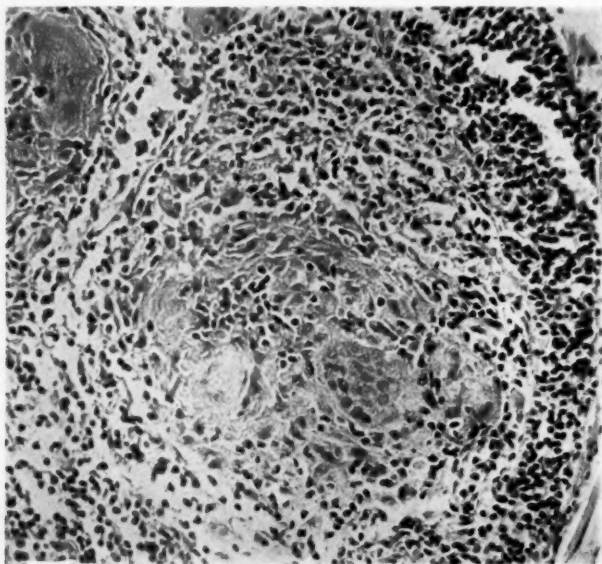


FIG. 5.—Case IV. Histogenesis of the giant cells. Section stained with Weigert-v. Gieson stain. Photomicrograph (220 diam.) showing various stages in the formation of giant cells by the fusion of epithelioid cells in a large typical tubercle.

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has been local with the common cautery. I have studied the following cases from the material in the Mayo Clinic:

HISTOLOGIC FINDINGS. SPECIMENS FIXED IN 10 PER CENT. FORMALIN, BLOCKED IN PARAFFIN, SECTIONS STAINED WITH WEIGERT-VAN GIESON AND UNNA PAPPENHEIM

CASE I.—The margin of the ulcer (involving the mucosa, the tunica propria and in parts even the muscular stratum) shows extensive small-cell infiltration of the connective tissue, but no typical tuberculous nodules are present. In the lower strata (of the margin of the ulcer) a few muscle fibres may be seen; these fibres have been split up into fragments by the small-cell infiltration, and are both degenerated and atrophic. The fundus of the ulcer, on the contrary, contains a great number of miliary foci, in which giant-cells may be seen; the latter are generally surrounded by lymphoid tissue, though a few epithelioid cells are found here and there. Caseous degeneration of these miliary tubercles appears to be extremely rare. The solitary tubercle as well as the larger tuberculous lesion, produced by the conglomeration of small nodules, is walled off by a dense zone of connective tissue. Extensive perivascular infiltration is found in every section.

Histologic Diagnosis.—Confluent ulcerating tuberculous granuloma.

CASE II.—The margins of the ulcer are composed of an intense small-cell infiltration, which has taken the place of all the original parenchyma. Here and there the infiltration is somewhat less dense, the cells are seen clustered together in groups and on the periphery of these groups lymphoid cells are found breaking up the muscular layer, the latter being atrophic and staining badly. In the lower strata, forming the fundus of the ulcer, numerous typical nodules appear; some of these, however, contain only lymphoid and epithelial cells. A few giant-cells are found scattered amongst the invading lymphoid tissue, although no attempt at tubercle formation could be traced. The blood-vessels show extensive perivascular infiltration.

Histologic Diagnosis.—Confluent ulcerating tuberculous granuloma.

CASE III.—The specimens removed at operation have not been preserved.

CASE IV.—Of the tuberculous nodule several blocks excised at different angles were examined in this case; all contain the same histologic picture. Numerous miliary tubercles are found, consisting of solitary nodules and of confluent groups of nodules separated by dense connective tissue containing very few nuclei (Fig. 1). The formation of individual nodules and the number of epithelial cells found in these nodules is characteristic of this particular type of tuberculosis of the tongue. In many of the nodules containing giant-cells of varied shapes and sizes, the nuclei being arranged peripherally or scattered throughout the cytoplasm, it is clearly shown that the giant-cell was formed by a gradual fusion of epithelial elements. The giant-cells appear to represent a form of syncytium due to the fusion of epithelial cells. In this case nodules containing lymphoid cells only are extremely rare. Bundles of muscle fibres that have remained intact are few and far between. They present the picture of disintegration already described above. They appear to have been separated and pushed aside by the infiltrative process when the latter began to invade the connective tissue. As usual the blood-vessels show extensive perivascular infiltration.

LUIGI DURANTE

Histological Diagnosis.—Intraparenchymal tuberculous granuloma, containing miliary nodules.

CASE V.—The margin of the ulcer, which involves the epithelium, the tunica propria and, in part, the muscular layer, shows intense small-cell infiltration as well as typical, nodular tuberculous lesions. Fig. 3 represents a large sclerotic tubercle found on the edge of the ulcer at the periphery, of which numerous giant-cells of various shapes and sizes may be seen. The inflammatory infiltration extends as far as the intrapapillary connective tissue in some places, invading the epithelium and paving the way for ulceration. The fundus of the ulcer also shows extensive small-cell infiltration and contains a great number of typical nodules in whose outer zone giant-cells are seen. A few muscle-fibres are found, both in the fundus and in the margin of the ulcer. These fibres are atrophic and stain badly. Extensive perivascular infiltration is seen around all the blood-vessels.

Histologic Diagnosis.—Intraparenchymal tuberculoma, containing confluent and ulcerating tubercles.

SUMMARY OF HISTOLOGIC FINDINGS

As may be readily seen from the description of the 4 cases mentioned above, the histologic picture found in tuberculosis of the tongue does not differ materially from that which is seen in the tuberculous lesions of other organs, especially of the striated muscles. Apart from the small-cell infiltration, which is not a typical feature in itself, the typical nodules characterizing tuberculous lesions may be observed in every case. In 2 out of 3 of our cases (presenting the ulcerating type of tuberculosis) these characteristic nodules could be observed only in the lower strata of the margin and in the fundus of the ulcer, a fact which suggests that in microscopic diagnoses both margin and fundus should be examined with special care. Three cases gave no data whatever concerning the actual histogenesis of the giant-cells. In the fourth, however, the formation of giant-cells as a direct result of syncytial fusion of epithelioid cells could be repeatedly demonstrated. The fact that extensive perivascular infiltration was found in every case seems to indicate that hæmatogenous infection plays a prominent part in the propagation of tuberculosis in the tongue.

SUMMARY OF CLINICAL OBSERVATIONS

Of the 5 cases of lingual tuberculosis I have described, 2 were women; in every case the age of the patient was between twenty and sixty. None of these came to autopsy. The question, whether any of these can be rightly described as "primary" tuberculosis of the tongue, must consequently be decided by the clinical findings. In Cases I and

TUBERCULOSIS OF THE TONGUE

IV no evidence of other tuberculous foci could be obtained by clinical means. In the 3 remaining cases, the lesions of the tongue appeared to be tardy secondary manifestations of primary pulmonary tuberculosis.

In 4 cases (I, II, III, V) the lesions of the tongue had already assumed the ulcerating form at clinical examination; the ulceration was most marked at the edges, the granuloma itself being embedded deep down in the tissue.

In Cases II, III and V the ulcer showed the typical characteristics of the disease, but in Case I both margins and fundus appeared hard and infiltrated and suggested an ulcerating epithelioma.

Case IV was of the nodular type and showed no change for ten years, at the end of which time the patient came for operation. The importance of the conditions under which tuberculous lesions develop, and the influence of these conditions on the progress of the disease and on the histologic picture which results, may be clearly seen in Case IV: The patient's personal history as well as the family history were entirely free from tuberculosis, the lesion found in his tongue may be called primary inasmuch as no other foci could be discovered during clinical examination; the lesion itself assumed the form of a "closed" (circumscribed) nodule, in which no changes occurred during a period of ten years.

In the other cases (I, II, III, V), however, all of which had a personal as well as a family history of tuberculosis, the tuberculous lesion in the tongue very soon (3 or 4 months) reached the ulcerating stage.

It is therefore safe to assume that the individual reaction of the body plays a far greater part in defining the histologic picture of tuberculous lesions, than the tissue in which the lesion is found.

In the four cases of "open," ulcerating tuberculosis of the tongue the regional lymph-glands were found to be involved. In Case IV, in which the intralingual granuloma remained intact, no such involvement was found.

Clinical diagnosis was easy in Cases II, III, and V, in which broncho-pulmonary lesions were present together with the ulcer of the tongue; a tuberculous lesion was suspected in Cases I and II. No definite diagnosis could be made (clinically) of Case IV, as no evidence of tuberculosis in other organs could be obtained.

In every case, however, a histologic diagnosis could be made during operation by means of frozen sections, and the histologic findings decided the course to be taken so far as operative and therapeutic treatment were concerned.

LUIGI DURANTE

Case	Date of admission	Office number	Sex	Age	Family history of T. B.	Accompanying tuberculous lesions	Trauma	Character of lesions	Number of lesions	Time of appearance before operation	Localization	Glandular involvement (cervical)	Treatment
1	Sept. 28, 1904	289	M	40	..	.....	Smoker (pipe)	Ulcer 8x6x4 mm.	1	3 mo. as deep-seated nodule	Left edge 2 cm. from point	+	Excision.
2	Jan. 2, 1906	1155	F	30	..	Bronchopulmonary T. B.	.....	Ulcer 12x8x6 mm.	1	3 mo. as deep-seated nodule	Right edge 1 cm. from apex	+	Microscopical examination for diagnosis. Caution.
3	June 8, 1907	A558	M	46	*	Pulmonary T. B.	.....	Ulcer 15x10x5 mm.	1	2 mo. as superficial nodule	Right edge 2 cm. from apex	+	Microscopical examination for diagnosis. Caution.
4	Jan. 28, 1909	A19632	F	46	..	.....	.....	Nodule under mucosa	1	10 years as nodule	Entire right half 2 cm. from point	.....	Excision.
5	Feb. 2, 1915	123733	M	24	*	Pulmonary T. B.	Smoker (pipe)	Ulcer 12x6x5 mm.	1	10 mo. as deep-seated nodule	Right edge 3 cm. from apex	+	Microscopical examination for diagnosis. Caution.

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TANNERS' ULCER*

CHROME SORES—CHROME HOLES—ACID BITES

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WITH BACTERIOLOGICAL AND PATHOLOGICAL STUDY

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A SURGEON should know much of the nature of many callings in order that he may understand the particular dangers to which the workers in each trade are exposed. In some callings the workman is in danger of wounds and injuries more or less grave; perhaps often fatal. The stress and strain of some shatter the nervous system. In some lack of exercise and contaminated air undermine the general health. In some irritant materials produce lesions of the surface of the body. In some poisons are absorbed and produce disease or death. In statistical tables, callings in which there is definite risk are designated as *dangerous occupations*.

We might give the following instances: Structural iron workers; workers in oil refineries; subway laborers; miners; railroad men; firemen in large cities, and workers in various other strenuous vocations are exposed to violence which may cause trifling injury or perhaps frightful mutilations. Caisson workers are liable to a peculiar disease. Locomotive engineers, overharassed professional men, business men during a financial crisis, persons living on the edge of ruin or exposure to disgrace, women in men's occupations, suffer from nervous strain and its resultant maladies.

In estimating the strain of an occupation it is interesting to note that the suicide rate in any calling is a fair measure of its strain and that the suicide rate is lower among beggars than in any other class.

Certain occupations cause definite neuroses. We may mention writer's cramp, telegrapher's cramp, pianist's cramp, typewriter's cramp, sewer's cramp, hammerswinger's cramp, etc. Sweatshop workers and dwellers in sunless alleys, those who live in the rabbit warrens of the tenements, are peculiarly liable to tuberculosis.

Among dangerous callings are the following: Work in lead, antimony, arsenic, mercury, copper, yellow phosphorus, carbolic acid,

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bisulphide of carbon, picric acid, certain petroleum products, nitro-explosives, and nickel carbonyl. The absorption of poisonous materials into the tissues of one who works with poisons produces results depending upon the material and the amount absorbed and the condition of the subject.

The local effects of irritants used in industrial processes are seen among workers in many callings. There are many forms of trade eczema and industrial ulcer. Electro-platers who work in strong soda solution may develop ulcers and fissures of the hand. Electro-platers may also get cyanogen sores. Bakers' itch is from working in flour and yeast; grocers' itch from sugar. Shoemakers, bartenders, stone-cutters, plasterers, bricklayers, printers, bookbinders, cigarmakers, photographers, chemists, surgeons, wood-workers and metal cleaners are prone to occupation eczema. Anthracene, a material from which alizarin dyes and a paint to preserve wood are made, is apt to cause the development of pustules on the skin and sometimes cause cancer. Workers in coal-tar and paraffin workers are liable to dry erythema, acne, pigmentations, pustules, boils, keratoses and warts; and a wart or an area of keratosis may become cancerous. In aniline and benzidine workers not only does cancer of the skin occur but also cancer of the bladder. Lampblack workers suffer from eczema of the toes, wool-sorters may get anthrax, salt grinders and salt handlers may develop ulcer of the nasal septum, and mother-of-pearl grinders may develop hypertrophy of a bone or bones and may suffer attack after attack of bone inflammation.

Among irritant materials used in certain industrial processes we must note chromic acid and its salts. This material in some form or other is used in photography, in calico printing, in bank-note printing, the ceramic industry, the manufacture of safety matches, dyeing, glass making, bleaching oils, purifying wood spirit and tanning hides.

It has long been known that the dust of chromic acid or the chromates can cause ulceration of the nasal septum and that the acid or the chromates, as dust or in solution, by acting upon the skin may cause ulcers.

Over twenty years ago one of us (DaCosta), then one of Professor Keen's assistants in the Jefferson Hospital, became interested in certain peculiar ulcers to which tanners were found to be liable, although occasionally a cloth handler or a dyer developed one. These ulcers were found to be most common on the hands, especially the fingers, but the feet were not entirely exempt. It was noticed that the ulcers tended to penetrate deeply, that few of them tended to spread much

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laterally, that they were painful, resisted all treatment until the occupation was abandoned, showed no sign of tuberculosis (cultures for tubercle bacilli proving negative), were not improved by antisyphilitic treatment, and after healing left permanent scars.

Further investigation showed that none of those attacked had worked in the old tanbark methods of tanning, but all had worked in the then recently introduced chrome process, which was being actively developed for the tanning of kid by Mr. Robert Foederer, of Philadelphia.

The only workmen in the tanneries who suffered were those who actually worked with the bichromate salts. Surgeons had heard of lesions arising in workmen engaged in the manufacture of bichromate of potash in chemical works, the lesions consisting of cutaneous ulceration and perforation of the cartilaginous septum of the nose. There was no record of such lesions occurring in tanners. Previous to this time the chromic process had scarcely been used.

A study of these ulcers was undertaken and a number of cases were investigated clinically and bacteriologically. The assistant engaged in the bacteriological part of the work tired and fled, the study broke down and was not resumed until recently.

Throughout the years which followed that abortive investigation every now and then a tanner suffering from an ulcer has presented himself for treatment at the surgical dispensary. The assistant came to speak of such sores as "tanners' ulcers" or "leather workers' ulcers." We still see these cases, though far less often than formerly because in certain parts of the tanning process machines have been substituted for hands.

Recently through the kindness of the proprietors of a number of tanneries in Philadelphia, Wilmington and Camden, we have seen and gathered together for study a number of these cases and purpose report upon them.

We will first set forth the literature on "chrome sores" in general, that is to say, of chrome sores as they occur in various occupations. We will then report upon our cases which occurred among tanners and will discuss the condition.

"CHROME SORES IN GENERAL"

Chromium and the chromates were discovered by Vauquelin in 1797. The chromates have been employed in certain manufacturing establishments since before 1819. On page 156 we mention some of the industries in which they are used.

Robert Christison (*A Treatise on Poisons*, 1829) tells us that chrome sores were described to him by his late colleague, Duncan, of Glasgow. His patients were dyers who worked in vats containing bichromate of potash. Christison states that these sores spread deeply but not laterally.

D. G. Gmelin, of Tübingen, in his *Treatise on the Effects of Some Metals* (quoted in *Edinburgh Med. and Surg. J.*, vol. xxvi, 1826), speaks of sores developed by Glasgow dyers who immersed their hands in bichromate solutions. The sores do not extend laterally, but go deeper and deeper and may penetrate the hand or forearm.

T. J. Ducatel, of Baltimore, studied chrome sores in chemical workers (*Manual of Practical Toxicology*, 1833). He states that if one who works in chrome has an abrasion of the cuticle a painful ulcer results; but if the cuticle is unbroken, even a strong solution fails to produce ulcerations. The writer states that chrome sores are well known to Baltimore chemical workers in factories where bichromate of potash is made. He asserts that Duncan's cases among dyers were due to free chromic acid in the fluid. He describes these sores in the words of Gmelin without giving credit to the celebrated Tübingen professor. He presumes that the neutral chromate can only induce slight inflammation. The bichromate causes much more violent symptoms.

Ducatel, in a footnote, quotes Baer as having seen twenty cases of chrome ulceration. Baer describes the ulcers as painful, burrowing, persisting in spite of treatment and tending to penetrate the limb unless the victim abandons his work. Baer asserted he had seen ulcers on parts of the body which the solution did not touch, and that such ulcers could only have been caused by the vapor of chromic acid.

In 1851 Chevalier, Sr., addressed a note to the Institute calling attention to the dangers run by those who worked in chromates. Heathcote (*Lancet*, February 4, 1854) reported ulcers of the throat occurring in workmen who handled chromate of potash, and claimed that such lesions might be fatal.

M. A. Delpech (*Bulletin de l'Académie Impériale de Médecine*, vol. xxix, 1863-1864) considers certain ailments of those who make bichromate of potash. He mentions pustules and gangrenous sores of the hands and feet (especially of the sides of the fingers and toes). These ulcers he says exhibit temporary induration, tend to perforate, and leave indelible scars. He further points out that ulcerous eruptions may occur on the arms, limbs, trunk or genitals; that ulcers are due to direct contact with neutral or acid chrome; that bichromate is the more active irritant of the two; that in some subjects rhinitis arises and ends

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in destruction of part of the cartilage of the nasal septum; that the perforation is usually rapid and the cartilage never reforms; that the sense of smell is seldom lost; that in some cases the perforation is insidious, without coryza; that the eyes, upper respiratory passages and stomach remain unaffected; that snuff takers seldom lose the septum from chrome perforation; that the nasal trouble is due to the vapor from the caldrons; and that both septum perforation and cutaneous ulceration are due to the escharotic action of chromic acid or a chrome salt.

In the same volume of the journal containing Delpech's paper is a paper by Hillairet on the dangers in making bichromate of potash.

In 1863, Chevalier, Sr., and Bécourt published a paper on the accidents to which chrome makers are liable (*Annales d'Hygiène*, July, 1863). The paper is founded upon an investigation conducted by Clouet and contains data obtained from Zuber and Ehrmann, of Rikshheim, and Isaac Tyson, of Baltimore.

In January, 1869, and in January, 1876, Delpech and Hillairet (*Annales d'Hygiène Publique et de Médecine Légale*) published studies of the accidents which occur to chrome workers. The paper contains a review of the very scanty literature, the report of an investigation of the hygienic conditions of chrome workers, a description of the process of manufacture and a clinical study of the health impairment due to chromate. It describes chrome sores of the hands and cases of perforation of the nasal septum and mentions that nasal perforation results from inhalation of chromate dust. In the same journal in January, 1876, there is published the second part of their study. The authors mention that though bichromate is distinctly more irritating than neutral chromate, neutral chromate can cause irritation (this fact has been disputed by manufacturers). They cite instances of animals who have walked about in a slop of neutral chromate and have developed ulcers on the feet, and report cases of perforations of the nasal septum due to the neutral salt.

The authors say that the ulcers are characteristic, that they are due to escharotic action and most of them arise in excoriations. In some cases there is perforation of the cartilage of the nasal septum, in some bronchitis, headaches and loss of weight. Ulcers of the throat simulating syphilis have been reported, but it is ~~un~~questionable if chrome causes them. If the hands are free from abrasions, they can be put in vats freely, but the slightest break will lead to ulcer. If there is an excoria-

tion, violent pain will be experienced at the moment of contact with the chrome salt. These ulcers are much worse in the cold of winter.

After an ulcer once begins it quickly indurates and in a few days a spongy, soft slough forms. These sloughs separate very slowly by peripheral ulceration. The sloughing area does not increase laterally unless more chromate is introduced, but it goes in deeper and deeper and usually reaches the bone; but once it does so, it stops. The edges of these ulcers are sharp cut and frequently show cicatrization. The core or slough is slowly separated, leaving a clear ulcer with a gray floor.

If a man stops work at once after the beginning of the ulcer, the sore quickly heals, but even then it leaves a permanent scar. The most common situations are in the articular folds on the back of the hand. He may get vesicles, pustules or eczema on various parts of the body. Sores on the body may be due to scratching with contaminated hands or may be due to dust settling through openings in the garments (it is to be remembered that the paper deals with chemical workers). The authors do not think that the systemic absorption of the chromium ever causes poisoning. Those who take snuff seldom develop perforation of the septum. Smell is seldom lost after septal perforation. After perforation has once occurred a second one never develops, because the contact of the mucous membrane of the two sides of the nasal passage has become impossible. The authors do not think that abrasions are a necessary antecedent of ulcers. If they were ulcers could not form on so many different parts of the body.

The writers then discuss at length industrial hygiene and prophylaxis.

In the quarterly publication for *Judicial Medicine*, vol. x, 2, 1895 (edited by A. Wernich), Dr. Paul Muller discusses perforating ulcer of the nasal septum. He says that the dust of many salts besides the chromates may be responsible. He mentions sodium chloride and potassium chloride.

Dr. J. William White (*University Medical Magazine*, November, 1889) reported a case in which he had used chromic acid as a cauterant for vegetations of the labia majora and nymphæ. The patient died within twenty-four hours, probably from the toxic action of the chromic acid that had been absorbed. The postmortem showed that the kidney tissue and the liver tissue contained sodium chromate. This acute case proves that absorption of toxic doses from the surface is at least possible.

Edward Curtis and R. J. E. Scott in Wood's *Reference Hand Book*

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of the Medical Sciences, 3rd edition, say that general poisoning from the continued absorption of small quantities of chromium is very questionable. They state that no *chronic* condition thus caused has been found in man.

Von Lewin (*Lehrbuch der Toxikologie*) says that chromium salts can be absorbed through wounds, from the skin and from mucous membrane. He cites the case of a boy who placed a piece of potassium bichromate, the size of a coffee bean, in his nose and went to sleep. In an hour he had developed serious symptoms of poisoning.

In Sajous's *Analytical Cyclopædia of Practical Medicine*, 1913, vol. iii, we read that potassium bichromate when applied locally to the skin may cause dangerous ulcers, and that workmen who handle cloth dyed with solution of chromates are apt to suffer from ulcers and eczema.

Imperial Medical Counsellor Dr. Wutzdorff published in February 13, 1896, a report called "Injuries to Health Observed in Chrome Factories, and Measures Required to Prevent Them." He reviews the literature on this subject and states that the report of the chemical works Committee of Inquiry in England, which was handed to Home Secretary Asquith in 1893, states that perforation of the nasal septum is frequently followed by impairment or actual loss of smell. He carefully analyzes the whole question of perforation of the septum and of all respiratory disorders. He reports many ulcers occurring in the workers of various chemical establishments. He states that the ulcers developed not only in abrasions or cracks but also in any places where chromate dust could settle and accumulate, as between the fingers and between the toes. He found no case of depressed nose. He thinks it possible that chromate may cause chronic nephritis in some cases. The diseases of the air-passages which occur seem to be secondary to the nasal affection, but perhaps they may also be directly due to the elimination of chromate salts through the air-passages. He notes a case where a 5 per cent. solution of chromic acid was used for excessive perspiration of the feet. Violent dermatitis, with symptoms of chrome poisoning, followed. Among other regions in which ulcers have been reported he notes the external ear and the eyelids. He found no ulcer that reached a tendon or a joint. It was said in one works that the bony septum of the nose had never been affected and that tobacco is no protection from attacks. Small number of ulcers of the mucous membrane of the palate and throat were noted in workers in one of the works. He discusses at length the causal relationship the work in manufacturing bears to health and says that the vapor arising from hot chromate solutions contains chromates. He then sets forth the procedures

to be undertaken to prevent injuries to health, insisting particularly upon the maintenance of cleanliness among the workmen and that when any chromate affection develops, the workman must be excluded from this work while the trouble lasts.

REPORT OF CASES PERSONALLY OBSERVED

One of us (Da Costa) has seen 44 cases altogether, 19 of which are here presented. Of the previous 25 there are no detailed records. Of the 44 cases, 5 worked in dye houses, 4 handled chromium hides, 2 worked in chemical works, 1 handled dyed cloth, and the balance were tanners. We are of the opinion that now and then a man who is wearing stockings containing dye fixed by chrome develops a genuine chrome ulcer of foot or toe. We have seen ulcers on the feet presenting all the ear marks of chrome ulcer and obviously due to recent local irritation, the victim never having worked in chrome. A prolonged case resembles the trophic or perforating ulcer of locomotor ataxia.

Of the 19 reported cases only 2 were Americans; the others were chiefly Italians, Austrians and Russians. This does not show any race predisposition or immunity. It simply shows how extensive is the invasion of our protected industries by foreigners. The ages were from sixteen to fifty-five. The period during which they had worked in chromates was between two months and eighteen years. Practically all the old workmen (seven cases) showed scars of previous ulcerations. One worked in chrome thirteen years and one four and a half years before developing an ulcer. The most common situation was in the folds of the dorsal surface of the fingers over or near the knuckles (Figs. 1, 2 and 3), but in one case we found ulceration on the palmar surface just below the metacarpal phalangeal joints (Fig. 4); two on the back of the hands; two on the dorsal surface of the forearm; one in the interdigital folds; one on the side of the last digit of the finger; one on the front of the knee; one at the edge of the nail (Fig. 5); one on the outer surface of the wrist; one on the back of the forearm, etc. In the old group of cases one was on the body near the groin and one on the inner surface of the prepuce. In such situations an ulcer is probably due to scratching with contaminated hands.

In practically all cases the ulcerated part had been kept wet by chromate solution. In one case several of the finger nails were lost several times in succession. The nails reformed with fair rapidity after the loss, which was quite painless. This man has no symptom of any disease of the spinal cord or nerves. In one case a finger was lost after perforation of a joint (Fig. 3).



FIG. 1.—Scars of chrome ulcers.



FIG. 2.—Chrome ulcer on dorsal surface of second finger.



FIG. 3.—Amputation as the result of chrome ulcer eating into joint. Active chrome ulcer present now.



FIG. 4.—Chrome ulcer on palmar surface of ring finger, over articulation; healed ulcer on thumb.



FIG. 5.—Scar of chrome ulcer on dorsal surface of distal phalanx of second finger near nail.



FIG. 6.—Chrome ulcer of index finger over an articulation.



FIG. 7.—Leather worker's ulcer in region of knee area; severely infected.



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FIG. 8.—Leather worker's ulcer with infected finger.



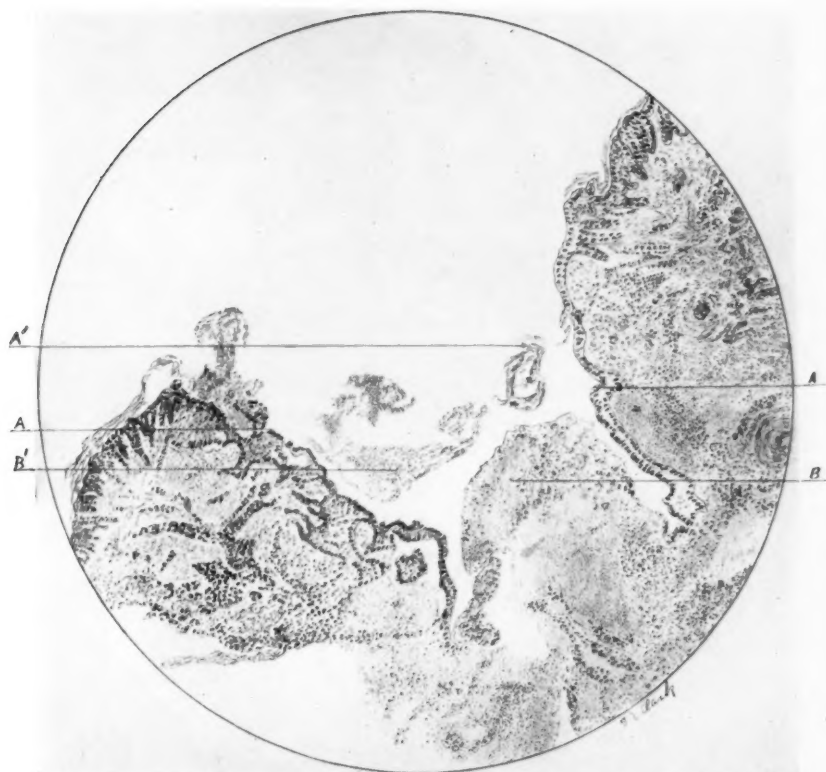


FIG. 9.—Leather worker's ulcer (chrome ulcer). *A*, *A*, walls of ulcer covered with epithelium; *A'*, island of cornified epithelium; *B*, floor of ulcer; *B'*, slough from floor of ulcer. Ulcer was 2 cm. in length, 1 cm. in width and almost 1 cm. in depth. The edges were very jagged and irregular, black in color, with induration. The floor of the ulcer was black in color, and in gross appearance contained what seemed to be masses of granulation tissue. The skin immediately adjacent to the ulcer was apparently normal, and presented areas of thickening. Sections were cut and stained with hæmatoxylin and eosin, hæmatoxylin and Van Gieson, with polychrome methylene blue; by Gram-Weigert and plain Gram technic. Histological study shows the ulcer to be clean cut and the edges lined or covered with stratified squamous epithelium. This cellular layer extends down to the floor of the ulcer and is apparently hypertrophied, as evidenced by the extensions into the connective tissue of the skin. In one area in the specimen is an isolated "island" of cornified epithelium (*A'*), evidently clipped off from a papilla of the skin. The floor of the ulcer is made up of nests of polynuclear leucocytes, areas of hemorrhage and cellular debris. Sections of sweat glands, or sebaceous glands, and of hair follicles are present, and in the immediate vicinity of these structures are accumulations of polynuclear leucocytes and some few round cells indicating a marked inflammatory condition. Irrespective of the structures above mentioned marked leucocytic infiltration is seen throughout the specimen and the blood-vessels all show marked thickening of the walls, some showing leucocytic infiltration between the coats. Recent as well as old areas of hemorrhage are present, some being immediately beneath the epithelium, while others extend down to the floor of the ulcer. When examined with the high-power objective numerous cells (leucocytes) are observed which contain pigment granules, brownish or brownish-black in color, especially in the areas of hemorrhage, while in one or two areas accumulations of these granules appear to follow minute capillary vessels. Bacteriological examination shows Gram-positive micrococci arranged in pairs and chains. No other organisms were observed. Results of inoculations from ulcers: Inoculations were made upon plain agar and into deep tubes of litmus lactose agar. These deep tubes were placed in an anaerobic condition. Of twelve cases studied, staphylococci (*aureus* or *albus*) were recovered in nine cases. Both *aureus* and *albus* were encountered in three cases. The bacillus *proteus vulgaris* was isolated in one case; a diphtheroid bacillus and the staphylococcus *pyogenes albus* in one; while the *sarcina lutea* and *B. megatherium* were observed in another. (These two latter cases were undoubtedly contaminations.) There was no difference in results obtained in the anaerobic condition. In one case no growth occurred.



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Duration of the cases we saw varied from a few days to seven months. The duration is indefinite. In fact, healing is not to be expected while the work is continued, unless the part is kept really covered by impervious gloves.

The chief characteristics of ulcers are induration, pain, and a tendency to deep penetration.

The longer the duration of the ulcer the greater the induration and the greater the ulceration. One of our cases reached a tendon, one entered a joint, and another reached the bone. Seven of these cases were single, twelve of them multiple. In several of the cases there were several ulcers and in one of the cases there were many ulcers. One case had nine ulcers. One of the cases of forearm involvement had a great number of small ulcers, apparently arising in hair follicles.

A number of writers have maintained that to develop an ulcer one must have first an abrasion, a fissure, a scratch, a wound, or a crack. The great majority of our cases presented some such antecedent condition but not all. In two of the cases the condition started in the hair follicles of the forearm, which part was frequently wet with the solution. In the one case ulceration began in the hair follicles of the dorsum of the hand. In the ulcer of the front of the knee (Fig. 7), the knee was constantly wet with the chrome solution but was not excoriated before ulceration. This ulcer became seriously infected and sloughed extensively. One started in an area of prickly heat and one began in an insect bite. The workman could always tell if the ulcer had started in an excoriation, because if there was such a break of continuity he felt severe sticking pain the moment the hand entered the chromate solution. While working, all ulcers will be violently painful. Most of them are very painful even when not working, particularly when exposed to cold, even slight cold. One of our cases kept his hands in his pockets, even in summer, to avoid draughts. Only one of our cases was free from continual pain. All are tortured by itching, especially at night. The patients are usually oscillating between the Scylla of pain and the Charybdis of itching. Warmth aggravates itching and cold, pain. Pain may be so severe as to seriously interfere with sleep. It is a burning pain with violent exacerbations. The ulcer will never heal while the man is working, if he does not wear rubber gloves, and it may last months or years. It usually takes weeks to heal even when work is stopped.

As previously stated, the ulcer usually begins in an excoriation, but this is not the invariable rule, as it may start in hair follicles or in an area of skin infection, for instance, eczema, acne, or in an area of

prickly heat. The ulcer is usually circular in shape, but, if it starts in a wound or fissure, has the shape of that breach in continuity. Its characteristic features are pain, induration and deep penetration. A raw, painful and tender spot is noted which enlarges little, if at all, laterally but which deepens day by day and becomes surrounded by a wide zone of induration. The ulcer may be a mere speck, may be a quarter or a half inch in diameter, or in exceptional cases, when severe pyogenic infection occurs, as large as the one shown on the knee in Fig. 7. A green or grayish core or slough forms in the centre. This becomes loose at the sides and becomes movable from side to side but long remains attached in the depths. In the deeper cases it is attached to a tendon sheath or to the periosteum. The ulcerated area with its surrounding induration moves with the skin until the ulcer reaches tendon sheath or bone and it then becomes fixed.

We had no case of perforation through a hand or forearm such as the early writers speak of as occurring in chemical works, but we have had one case of perforation into the second phalangeal joint of the ring finger of the right hand, which caused the loss of the finger (Fig. 3).

When the slough separates the discharge lessens and the healing begins from the periphery. During healing the edges seem to shrink and to reach a lower level than the ulcer or than the exuberant granulations which sometimes protrude from the sore. An ulcer may make abortive attempts to heal. It may heal on the top so that a cavity remains in the indurated area, a cavity which is roofed in and contains seropus. This may occur over and over again. The formation of a crust is usually an indication that healing is beginning. The workmen all regard it as having this significance. The edges of the ulcer are usually perpendicular and remain so unless severe pyogenic infection arises. In nearly all cases the parts about the ulcer are densely hard. This indurated area is seldom narrow. It is usually one-eighth of an inch broad or even more. If the ulcer is not very deep the indurated area moves with the skin. The more superficial the ulcer the more movable it is and the less the induration. The deeper the ulcer the less movable it is and the greater the induration. When the ulcer extends to tendon sheath or periosteum it is entirely fixed.

The floor of the ulcer is pale pink or pale gray. It shows no granulations until the slough is loose or separated. The discharge is usually thin, scanty and purulent; being commonly yellow in color, but sometimes colorless. In some ulcers there is practically no discharge observed on dressings. A little can always be found by squeezing. In one case of severe infection there was a profuse watery discharge.

TANNERS' ULCER

The area around the ulcer is usually markedly red for a short distance and may be oedematous (Fig. 8). Some cases are bright red for a quarter of an inch about the ulcer. This means that the ulcer is not healing. The parts near about a healing ulcer are pearly white. It is not unusual to find eczema in this region. The scar which forms eventually becomes soft and loses much of its hardness as time goes on. It becomes markedly depressed, is not tender and, though first of a brownish hue, becomes pearl white. It is usually smooth but may be corrugated. In only one of our cases was there marked swelling of the hand. In this case there was cellulitis. The hand was greatly swollen and red lines of lymphangitis showed on the forearm and arm. This was the one case in which related glands were involved. In no case were there any constitutional symptoms to suggest general poisoning by chrome, and in no case were there signs of perforation of the nasal septum, ulceration of the larynx or respiratory disturbances.

Fig. 9 shows a microscopical study of a chrome ulcer and the legend contains the bacteriological report by C. Rosenberger and his description of the ulcer.

The workmen adopt various means to prevent these chrome sores when they have any excoriations upon the hands. Some wear finger tips of rubber, some apply waterproof court plaster, some apply collodion, some rub their hands with oil before putting them in the chrome salt, some wash them in a solution of carbonate of sodium on ceasing work. As a general thing the workmen use some salve for the abrasions but some workers maintain that any ointment does harm. It has been my custom to treat the cases during the progressive stage by washing them first with carbonate of sodium and then several times a day with peroxide of hydrogen and dressing them with lead water and laudanum.

Hot-water bags are used for pain. Soaking in hot lead water gives relief. Surgical removal of the slough does harm. The manufacturers maintain that the condition will seldom arise if the workman is careful to clean his hands and that he will have no severe trouble if he will stop work when he has an abrasion. Many of them dwell on the notorious carelessness of workmen. One manufacturer wrote me that oiled hands were a great protection. He also stated that similar sores occur from hydrochloric acid, from lime and from sulphide of sodium, and says that carbonate of soda has long been recommended as a wash for chrome stings.

Isaac Tyson, of Baltimore, recommended that the sore be painted once with a solution of nitrate of silver in order to form insoluble

chromate of silver. Chevalier, Sr., and Bécourt recommended dressing with weak lead acetate and dilute alcohol and have stated that soaking in dilute lead water for four or five minutes will relieve pain and enable the patient to get sleep.

We have received the following important communication as to the prevention of chrome sores among tannery workers. It was sent us by Dr. Louis Levi, Chief Chemist to the Pfister and Vogel Leather Company, Milwaukee, U. S. A. He says that chrome sores tend to become very painful and eat very deeply. He has tried all kinds of alkaline and neutral ointments for the cure of this disease and without success. He therefore determined to try and find some means of prevention. He has prepared a very efficient ointment which he has now been using for a year and the cases have dropped from four to six a week to two in six months.

He orders that the ointment be applied twice daily. Three parts of petrolatum are mixed with one part of lanolin. This mixture is melted on a water-bath or stove and when melted and thoroughly mixed, ten to fifteen drops of 90 per cent. carbolic acid are added to every 400 grammes of the mixture. This represents five drops of acid to four grammes of ointment. The material is placed into a glass or earthenware jar and allowed to solidify until ready for use. The workman cleanses his hands and arms thoroughly with soap and water, rinses with warm water and, while the parts are still moist, applies the ointment. He rubs it over the whole exposed area for about two or three minutes. He then takes a clean cloth and wipes the skin entirely dry. Doctor Levi says that the lanolin is absorbed by the skin and that the petrolatum forms a light coating on the surface. The petrolatum will keep most of the chrome away but, should this outer coating of petrolatum wear off, the lanolin in the skin will still prevent the action of the chrome. Doctor Levi published this method in the *Hide and Leather Review*, London, England.

MULTIPLE CARTILAGINOUS EXOSTOSES (HEREDITARY DEFORMING CHONDRODYSPLASIA) *

WITH NOTES OF NINE HITHERTO UNPUBLISHED CASES

BY ASTLEY PASTON COOPER ASHHURST, M.D.

OF PHILADELPHIA

THE clinical entity which goes under the name of multiple cartilaginous exostoses has recently been studied by Ehrenfried, who prefers the name hereditary deforming chondrodysplasia. According to Rendu and Levy its relation to chondrodysplasia was recognized by Ollier as long ago as 1899. G. G. Davis says it was described as a clinical entity by Caesar Hawkins, in 1837. Ehrenfried found only about twelve cases which have been reported in America, the greatest number being reported from Germany and France. Inasmuch, however, as I have myself had the opportunity to see no less than eleven such patients within the last ten years it is evident that the affection is not really rare, but merely has been ignored, because there is so little that can be done in the way of treatment.

The affection is more frequent in males than in females, is distinctly hereditary, may be transmitted by both affected males and females, but there is no good evidence that it may be transmitted by unaffected males, though it may be transmitted by unaffected females (Reinicke, 1890; Lippert, 1903). The essence of the disease is not the exostoses; these are merely incidental (Lenormant, 1905). This has received especial recognition since the more common use of X-rays, but was suggested by Ollier and others long before the advent of skiagraphy. As a matter of fact, the underlying pathological change is a chondrodysplasia, affecting especially the metaphyses of the long bones, though the bones of the pelvis, the clavicles, scapulæ and the vertebræ may be involved also. In skiagraphs the bone ends may look cystic (Fig. 2), owing to irregularly distributed areas of cartilage in the metaphyses. The epiphysis itself is small or misshapen, the intermediary cartilage is narrow, irregular, oblique, or zigzag, and sometimes prematurely ossified (Lenormant, 1905). Scattered along the ends of the shaft beneath the periosteum are to be found clumps or nests of cartilage cells persisting uncalcified where they

* Read before the Philadelphia Academy of Surgery, October 4, 1915.

were left in the process of growth. Later these groups may develop into cartilaginous exostoses or chondromas (Ehrenfried, 1915).

Certain secondary characteristics usually but not always are present, and are easily recognized (Bessel Hagen, 1891). These are a low stature, due to shortness, not of the trunk, but of the limbs; as a rule the lower limbs are more shortened than the upper. There often is a lack of growth of the ulna, resulting in relative overgrowth in length of the radius, which becomes luxated at one or both ends, especially at the elbow. Thus the condition has been mistaken for "congenital dislocation of the radius," and according to Bessel Hagen most cases so described really were cases of this dyschondroplastic affection and in no sense instances of a congenital dislocation. *Pes valgus* is a frequent development from lack of growth of the fibula, with relative overgrowth of the tibia.

The deformities above enumerated may come before the exostoses, and the latter may never develop. Exostoses may develop in cases of very slight or insignificant deformities; or exostoses may be present on undeformed bones while the same patient may have other bones which are deformed but without exostoses.

Occasionally a malignant osteocartilaginous tumor develops in one of the exostoses. Ehrenfried says Lenormant and Lecène collected 24 such cases, and he has himself found references to about a dozen more.

Patients usually come under observation at or about puberty, for *pes valgus*, for painful pressure by one or more exostoses, or for general bone pains. After skeletal maturity the disease usually ceases to progress; but in the remarkable case reported by G. G. Davis (recorded below as Case 10) a man who had had exostoses since childhood began to develop new tumors when past fifty years of age, after a quiescent period of more than 30 years. In the patient recorded below as Case 8, moreover, there is no certain knowledge of the existence of the exostoses before the age of thirty years. But if we remember that exostoses are incidental features of the affection, there is no reason, so far as I can see, to deny the possibility of their appearing for the first time in adult life.

I give below a brief abstract of the cases which have been under my own observation. Unfortunately the hereditary character of the disease is not very apparent in this series, most patients denying that any other members of their family were similarly affected. But it is very likely that closer investigation might have discovered some such cases.

MULTIPLE CARTILAGINOUS EXOSTOSES

CASE I.—Ella C. M., aged four years, was referred to the Orthopædic Service of the Episcopal Hospital by Dr. Henry Winsor and Dr. James W. Ellis, September 20, 1915. This girl is her parents' only child; the mother has had no other pregnancies. The parents are both healthy, and the family history is otherwise negative. The child was normal at birth. From the age of 11 months to 20 months she suffered from enteritis, and had an intercurrent attack of measles at the age of one year. Since then she has been healthy, with the exception of an attack of varicella about three months before coming under observation.

About one year before seen by Dr. Ashhurst, the child fell and bruised her left knee. When her mother came to rub it for her she found a lump on the outer side above the knee. No further trouble was experienced, and it was not until about six or seven months later that the mother noticed similar bony lumps on the upper part of the left humerus and at the right elbow.

Examination at the present time shows a fairly well developed and nourished child, with no subjective symptoms. The mother thinks the lumps have not increased in size much if at all since they were first noticed. There are exostoses in the following locations: Two on the spine of the right scapula, one on the upper angle of the left scapula, one on the fifth right rib, near its cartilage; one on the upper end of each humerus, that on the right apparently arising from the lesser tuberosity, and that on the left from the greater tuberosity; one on the upper end of the right ulna, inner side; one above the external condyle of the left femur; one above the external malleolus of the left fibula.

The head of the right radius is unduly prominent, as if subluxated.

Many skiagraphs were taken, but as the child was very refractory and would not be still, none of them are sufficiently good to be reproduced as half-tone illustrations.

CASE II.—Philip W., twenty years old, seen in Dr. Davis's service at the Orthopædic Hospital, April 17, 1906 (Book xviii, p. 118). Exostoses first noticed at age of three months. There are now exostoses on nearly all the bones; in both forearms the radii are longer than the ulnæ, and the hands deviate to the ulnar side. There is moderate valgus in both feet.

CASE III.—Edna U., eleven years old, negress. Seen in my dispensary service at the Children's Hospital, August 13, 1907. There are four other healthy children, and so far as known no one else in family has any similar affection. No history of tuberculosis. The patient began to walk at age of nine months, and so far as family knew was perfectly normal until three years ago,

when exostoses began to appear, and have been growing larger since. She comes for pains in her bones. The photograph (Fig. 1) shows many of the exostoses. The right radius was 21 cm. in length, and the left 18.5 cm. There is some shortening of the ulnæ, and slight valgus in both feet from deformities in the leg. She was under treatment at this time for 7 months, and her pains lessened while taking the syrup of the iodide of iron. Three years later she was seen at the Orthopædic Hospital, in Dr. Davis's service, for pronounced valgus in both feet. As the condition was painful, braces were ordered including the legs.

CASE IV.—Fred R., aged seventeen years, was seen in Dr. Davis's service at the Orthopædic Hospital, November 12, 1907 (Book xx, p. 14). The family history is recorded as negative. The boy had had typhoid fever in 1897, when eight years old. About one year later he first noticed an exostosis over the upper inner end of left tibia. One year later a similar growth appeared in a corresponding situation on the right leg. Then gradually others formed all over the long bones. The left knee is markedly bowed (outward). The right lower extremity measures 88 cm., and the left 91 cm., being longer than the right in spite of the bowing of the knee.

CASE V.—Henry B., fifteen years old, was seen in Dr. Davis's service at the Orthopædic Hospital, January 21, 1908 (Book xx, p. 62). His brother, with the same affection, is recorded below as Case VI. Another brother, also said to have multiple exostoses, was not seen. Henry has had the affection for seven or eight years, and for five years had to wear leg braces on account of pain and weakness. There are exostoses on all long bones, on both clavicles, both scapulæ and on the pelvis, but none on the hands or feet.

CASE VI.—Mason B., aged thirteen years, seen in Dr. Harte's service at the Orthopædic Hospital, March 19, 1908 (Book xiii, p. 58). Two brothers have multiple exostoses. One is recorded above as Case V. Mason has noticed the present condition about two years. He comes for valgus deformity in both feet. The right leg, from knee to ankle, is 1.5 cm. shorter than the left.

CASE VII.—Herbert T., aged fourteen years, seen in Dr. Harte's service at the Orthopædic Hospital, February 11, 1909 (Book xiii, p. 215). The boy came for weakness in the left arm, which had existed for a year. There was paralysis of the left ulnar nerve, evidently due to pressure of a bony mass in the neck (Fig. 2). Over this mass there was a keloid scar from an operation performed four months previously in another hospital. So far no improvement had followed this operation. There were also exostoses of the right humerus, left femur, left tibia and



FIG. 1.—Case III. Multiple cartilaginous exostoses in a negro girl of eleven years.



FIG. 2.—Case VII. Multiple cartilaginous exostoses. The mass in left side of neck has caused paresis of ulnar nerve. Note involvement of vertebral border of scapula, exostosis on upper metaphysis of humerus and cystic (cartilaginous) appearance of underlying bone.



FIG. 3.—Case VII. Multiple cartilaginous exostoses.



FIG. 4.—Case XIV. Exostosis above internal condyle of femur.



FIG. 5.—Case XV. Exostosis excised from humerus.



FIG. 6.—Case XVII. Traumatic hyperostosis of the humerus, four months after a fall on elbow.

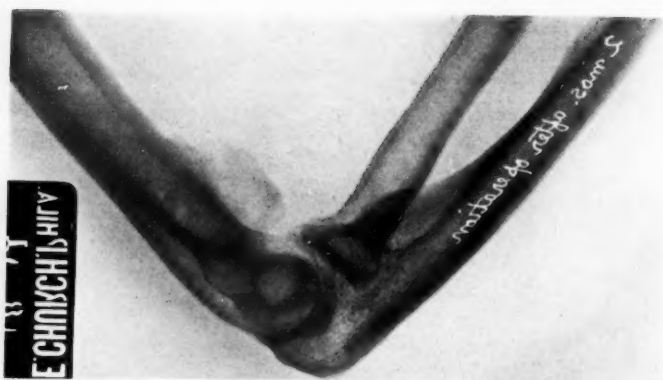


FIG. 7.—Case XVII. Recurrence of hyperostosis of humerus two months after operation.



FIG. 8.—Case XVII. Gradual absorption of new-formed bone, nine months after operation.

MULTIPLE CARTILAGINOUS EXOSTOSES

fibula. A photograph (Fig. 3) shows considerable valgus deformity in the feet, and moderate shortening of the upper extremities, and some of the lower extremities, as the midpoint of stature is not at the pubis, but half way between it and the umbilicus.

CASE VIII.—Alexander M., thirty years old, seen in Dr. Davis's service at the Orthopædic Hospital, June 8, 1909 (Book xxii, p. 19). The family history is negative. The patient had never been ill, and denies all venereal disease. The present complaint was noticed after what he calls an attack of "rheumatism" for which he says he was treated from December, 1908, to March, 1909. Until the latter date he did not know of the existence of any exostoses. At this time Dr. Davis removed an exostosis from the left femur, which was pressing on the sciatic nerve (possibly the cause of his "rheumatism" during the winter), and one from the left fibula.

CASE IX.—Mary R. B., aged seven years, seen in Dr. Davis's service at the Orthopædic Hospital, August 10, 1909 (Book xxii, p. 84). The exostoses were noticed before the child was one year of age. They are present on all four extremities, on the scapulæ, and one is forming on the left ribs. The child was brought for pronated feet.

I have also seen the two patients reported by Dr. Davis in the monograph already mentioned:

CASE X.—A man, aged fifty-three years, whose exostoses began to appear when he was about ten years old. After the age of fifteen or sixteen years, the disease became more or less stationary, except for gradual impairment of joint motions. At the age of fifty-two years an exostosis developed on the left ramus of the pubis; this growth subsequently grew smaller while the patient was under Dr. Davis's observation. The man suffered from considerable pain in his bones, and was incapacitated for work. A photograph published by Dr. Davis, as well as numerous skiagraphs, shows the typical deformities characteristic of the disease, namely, relative shortening of ulnæ, with ulnar deviation of the hands, and subluxation of the head of the left radius; right knock-knee, and valgus in both feet.

CASE XI.—A child (sex not recorded) aged three years, with multiple exostoses, which were first recognized by the mother before the child was one year old. The digital phalanges were involved as well as all the long bones of the limbs. The child also was rhachitic, and knock-knees were present.

There are also brief records at the Orthopædic Hospital of the following two patients, in Dr. W. J. Taylor's service. They did not come under my personal observation:

CASE XII.—Edward S., aged sixteen years, January 26, 1907 (Book xiii, p. 12). Has had knock-knee since childhood; had typhoid fever 4 years ago. Has several exostoses on or near each knee.

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CASE XIII.—Hugh McN., aged thirty-four years, March 5, 1910 (Book xv, p. 31). Has presented symptoms due to exostoses for 2 years. Exostoses are present at right wrist, left elbow, and left scapula.

Owing to lack of details it is not certain that these cases (XII and XIII) are instances of hereditary deforming chondrodysplasia. But the more one looks into the matter, the more difficult does it become to draw any definite lines between well defined "typical" cases and those which are just on the verge of typical. At the other end of the scale come those patients who present one or at most two or three exostoses, which have developed without any evident cause, or have been discovered after a slight injury which may or may not have been an etiological factor. These patients present no indication of any hereditary affection, and no skeletal deformities are noticed. It is of course possible that in such cases a thorough skiagraphic examination might reveal evidences of chondrodysplasia in bones showing no other evidences of disease, or might even show other insignificant exostoses.

The following cases, for instance, are to my mind examples of chondrodysplasia of some sort:

CASE XIV.—Annie S., aged sixteen years, was seen in Dr. Harte's service at the Orthopædic Hospital, July 27, 1911. Two years previously she had struck her left thigh against the runner of a sled, and three months later a bony lump appeared. She complained of pain in the lower part of her left thigh when walking. The lump was a typical cancellous exostosis, springing from the femur above the internal condyle (Fig. 4), and I excised it with the cortex from which it sprang, September 7, 1911.

CASE XV.—Jennie F., aged thirteen years, referred to my service at the Episcopal Hospital by Dr. R. S. Hooker, in May, 1914. A bony lump had been noticed at the right shoulder for three weeks; there was no history of injury. The exostosis, springing from the humerus and presenting beneath the anterior fibres of the deltoid muscle, was excised with the underlying cortex, May 13, 1914 (Fig. 5). There has been no recurrence to date.

CASE XVI.—Grace J., aged fourteen years, came to my service at the Orthopædic Hospital, October 31, 1914. About September 1, 1914, she had fallen on the stairs, and twisted her shoulder in the banisters. About a month later she noticed a lump on the right scapula. This caused pain, and seemed to be growing larger. On December 12, 1914, I excised it. It sprang from the upper vertebral angle, and the portion of bone from

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which it grew was removed in one piece with it, including the entire thickness of the scapula. Recovery was uneventful. About four months later the girl returned, complaining of neuralgic pains beneath the right pectoralis minor, and shooting back to the scapula. Skiagraphs showed no bony lesion. The girl was referred to the nervous department of the hospital for an opinion, and Dr. F. W. Sinkler reported that he considered her neurasthenic. At all events she recovered from her pains without further surgical treatment.

Two utterly different types of cases, it seems to me, are those recorded by me in the remaining pages of this article—one a traumatic hyperostosis, the other an instance of osteophytes accompanying chronic hypertrophic arthritis.

CASE XVII.—Traumatic hyperostosis of the left humerus, recurring after operation, but eventually disappearing spontaneously.

Mary D., aged twenty-four years, was seen in the Orthopaedic Service of the Episcopal Hospital, June 1, 1914. Four months previously she had fallen down ten steps, landing on her left elbow. Her physician said it was dislocated, but an X-ray showed no bone lesion. It was bandaged for some weeks, but remained painful.

When examined at the Episcopal Hospital, four months after the accident, there was marked disability, with constant pain in and above the elbow. There was full extension and normal rotation, but flexion of the elbow was stopped by bony contact at 80 degrees. A bony mass could be felt in the flexure of the elbow a little to the median side of the midline between the condyles. An X-ray showed a mass of bone in the flexure of the elbow (Fig. 6) apparently arising from the humerus, possibly from the muscle. The patient readily consented to have the excessive bone removed by operation, as she was unable to do her work (house-work).

*Operation (June 29, 1914).—*Under Esmarch anæmia a longitudinal incision was made along the median edge of the biceps muscle, displacing the brachial vessels and median nerve to the median side. This gave ready access to the growth, which, as shown by the X-ray, sprang from the humerus, nearer its median than its lateral border. The growth extended down to the trochlear surface. It was covered by periosteum which appeared normal, and did not in any way involve the muscles. The mass with its overlying periosteum was removed by gouge and mallet, until the normal contours of the humerus were restored, and normal flexion of the elbow was possible.

The pathological report, by Dr. C. Y. White, Director of the Pathological Laboratories of the Hospital, stated that the specimen was composed of cancellous bone containing areas of granulation tissue.

July 20: Elbow flexes further than before operation. A bony mass is still felt over the lower anterior part of the humerus.

August 3: Flexion to 65 degrees and full extension.

August 31: Flexion to 60 degrees. Some pain in damp weather.

X-ray shows recurrence of bony growth in flexure of elbow (Fig. 7).

March 8, 1915. Nine months after operation. Flexion to 50 degrees, extension normal. Never any pain or disability. X-ray shows scarcely any thickening of the shaft at the site of the former hyperostosis (Fig. 8).

CASE XVIII.—*Osteophytes of humerus, accompanying chronic arthritis of the shoulder; excision with permanent relief of symptoms.*

John C., aged sixty-two years, broom-maker. Blind since age of twelve years, as the result, he says, of an attack of typhus fever. He was seen in the Orthopaedic Service of the Episcopal Hospital, August 5, 1913. About 15 years previously he had fallen and injured his right shoulder, and it had given him constant discomfort since. In December, 1912, this shoulder gave a sudden crack while at his work of making brooms, and he had been unable to work at all subsequently until the present, on account of the pain in his shoulder on any motion.

Examination showed a well-preserved but thin old man, not at all robust. There was no limit to passive motion in the shoulder-joint, but very marked crackling on external rotation and very great tenderness over the tuberosities. On elevation of the arm the tender points disappeared under the acromion. A skiagraph showed no bony lesions other than some hypertrophic changes in the acromioclavicular joint, where he had no symptoms. Operation was undertaken as an exploration, in the expectation of finding some periarthritis with bursal adhesions.

Operation (August 15, 1913).—Ether. An incision from the point of the acromion downward for three inches was made, splitting the anterior fibres of the deltoid. No evidence of any subdeltoid bursa was found. Immediately beneath the deltoid the very thin capsule of the shoulder-joint was exposed, and on opening this the head of the humerus was found to be eroded and flattened. The external part of the head was much flattened, and there were two osteophytes at the margin of the articular cartilage (just at the reflection of the capsule on to the ana-

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tomical neck), which caught on the capsule during rotation outward, and caused a distinct *jump* and crackling. These two osteophytes were removed by gouge. They were about 6 or 7 mm. high. The long head of the biceps, on the inner side of the incision, seemed to be intact.


Pathological Report (Dr. C. Y. White).—Compact bone, denser than normal, covered with cartilage on its free surface. No evidence of inflammation.

The subsequent history is brief and satisfactory. The wound healed promptly, all pain was relieved, and the man returned to his work. He was last seen September 6, 1915, more than two years since operation. He has not had a pain or a twinge in that shoulder since operation, and continues his work without disability, except that he is now developing a Dupuytren's contracture in the palm of the right hand.

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TREATMENT OF VARICOSE LEG ULCERS*

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VARICOSE leg ulcers belong to that class of maladies for the cure of which a host of therapeutic measures is recommended. The purpose of this paper is to show both the fallacy and the futility of expecting a cure of varicose leg ulcers by drug therapy alone, and to prove that the most efficient therapeutic measure is the *vis medicatrix naturæ*.

Varicose veins are a penalty of the upright position. Reduced to its simplest terms, the pathology is primarily that of chronic venous congestion, mechanical in origin. This simple etiologic factor underlies all the secondary effects, such as ulceration, infection, fibrosis and bone involvement.

The rational treatment of varicose leg ulcers, then, must be based upon measures that combat the phenomena attendant upon chronic venous congestion, namely, transudation of serum and migration of blood-cells into the connective-tissue interspaces, and the inevitable fibrotic thickening of the walls of the connective-tissue interspaces.

Reduced to its simplest terms, the rational treatment of varicose leg ulcers, based on their pathology, depends upon the recognition and application of the principles of, first, protection, second, drainage, and, third, support.

(1) *Protection*.—Any ulcer is cured when epithelialization of its entire surface is complete. Epithelialization of the ulcer surface will not occur in the presence of an unhealthy ulcer base. The ulcer base is made healthy by affording drainage of the matter discharged from it and by giving it proper support. With the ulcer properly drained and supported the epithelium at the margin of the ulcer begins to regenerate. Because of its delicacy of texture and superficial position, this regenerating epithelium requires protection, lest it be torn away during the change of dressings. The best protective agent is a material that has a perfectly smooth surface. Such a protective agent is rubber tissue. When the ulcer is large its epithelial edge may be efficiently protected by being covered with strips of rubber tissue cut to about one-fourth inch in width (Fig. 2). When the ulcer is small a piece of rubber tissue may be cut to the size of the ulcer and a hole made in the centre of the

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piece of tissue to afford an outlet for the discharge from the ulcer into the superposed dressing. If no outlet be provided, this discharge accumulates beneath the rubber tissue and most effectively macerates the regenerating epithelial edge. This macerating action constitutes a valid objection to the no-drainage method of smothering the ulcer with an impervious unguent dressing.

(2) *Drainage*.—As just stated, provision for the escape of the discharge from the ulcer is made by cutting a hole in the centre of the piece of protective rubber tissue. The amount of discharge will lessen as the œdema of the tissues subsides from the pressure of the bandage.

What is the best form of dressing to take up the discharge from the ulcer? The tissues are already more or less water-logged, so why apply a wet dressing? A wet dressing does not remain wet very long unless evaporation of its contained fluid be prevented by such an impervious material as paraffin paper or oiled silk. But a wet dressing covered by an impervious material merely increases the maceration of the already macerated tissues, and, furthermore, it is impracticable for the patient to keep the leg dressing moist until the time of the next visit.

Plain, dry, sterile gauze admirably meets the requirements of a dressing that will take up the discharge without increasing the water-content of the tissues. It may be objected that dry gauze placed in direct contact with a granulating surface would act as a mechanical hindrance to the granulations by their becoming adherent to it and growing into it, so that at the change of dressings the granulations would be traumatized by removal of the gauze. Practically, however, the granulations do not become adherent to the gauze owing to the slimy character of the discharge from the ulcer. The only place where the gauze could become adherent is at the epithelial edge of the ulcer, but the epithelial edge is already protected by the rubber tissue. When the dressing is removed it comes away freely without sticking at any spot.

(3) *Support*.—It is a well-known clinical fact that the very best treatment of varicose leg ulcers is by the non-ambulatory method, of rest in bed with elevation of the limb involved. The explanation of the superiority of the method of rest in bed with elevation is, of course, that the chief etiologic factor in the development of varicose veins—the attraction of gravity for the long column of blood in the saphena magna—is overcome; the œdema of the tissues subsides, and with the subsidence of the œdema the nutritional state of the tissues is improved, and improvement of the nutritional state enhances the power of tissue repair. But few patients, however, can afford to take to bed on account

of a leg ulcer. We are forced, therefore, to combine with the ambulatory treatment the advantages of the non-ambulatory.

The best substitute for rest in bed with elevation is support of the limb; the best method of supporting the limb during the active treatment of large or multiple leg ulcers is by the application of a roller bandage, not of gauze, but of muslin; and the best type of bandage to apply is the spica, or figure-of-eight of the leg.

While commonly used, yet gauze bandages do not support the tissues as firmly as muslin bandages support them, and gauze bandages have a tendency to roll up and become disarranged. The spiral reverse bandage of the leg, advocated by some, looks prettier in the text-books than upon a patient's leg. In everyday practice a spiral reverse bandage cannot be applied upon an inverted cone, such as the leg below the calf represents, and be expected to remain in place for forty-eight, or twenty-four, or even six hours, however long the patient may be up and about.

Given one or two ulcers of limited size where healing is delayed by induration at the base and periphery of the ulcer, and provided that the skin is healthy, there is no better method to effect epithelialization than that suggested so long ago as 1792, by Thomas Baynton, of Bristol, namely, firm strapping of the ulcer by imbricated lengths of adhesive plaster applied from below upward and encircling the limb for two-thirds of its circumference (Fig. 1). When treatment was begun upon these ulcers they were indolent and sluggishly inactive, and had been for several weeks. The sketch shows the improvement after a week's strapping: from being indolent and sluggishly inactive the ulcers were transformed into healthy, rapidly epithelializing and granulating wounds, the contrast between the pure blood-red and firm granulations and the broad, bluish-white band of rapidly regenerating epithelium being so striking as to merit reproduction in tints. It is my practice to fill the excavation of the ulcer flush with the skin with a powder before applying the straps of adhesive plaster, and for this purpose I have found calomel the most useful powder. The powder serves as an agent for transmitting the pressure and support of the adhesive straps to the floor of the ulcer; without powder the straps would merely bridge across the excavation of the ulcer.

The striking efficiency of the strapping method is purely in keeping with the old surgical principle that pressure upon tissues promotes absorption of fluids and, later on, atrophy of the tissues themselves. As the induration at the base and edges of the ulcer melts away under the influence of the pressure exerted by the straps, the blood-channels

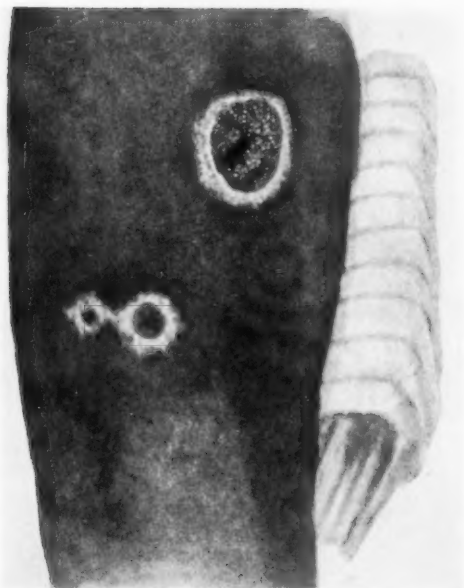


FIG. 1.—Indolent ulcers converted into the classic healing variety by the calomel-adhesive-plaster method. Note firm, bright red granulations and encircling broad band of bluish-white, rapidly regenerating epithelium. Straps curled back for sketch. Author's case (*International Clinics*, 1913, vol. iii, 23d series, p. 210).



FIG. 2.—Photograph of multiple varicose leg ulcers taken at beginning of the mechanical method of treatment. Note protection of epithelial edges by strips of rubber tissue.



TREATMENT OF VARICOSE LEG ULCERS

are opened up, and instead of there being an excess of venous over arterial blood, the proper proportion is restored by the venous blood being permitted egress from the ulcer, and the healing arterial blood ingress into the ulcer.

For the routine treatment of the average varicose leg ulcer nothing serves better—nor is there any more economical form of support—than Unna's zinc oxide and gelatin paste enmeshed in a gauze bandage so as to form a stocking with the consistency of rubber. Upon the patient's return the Unna stocking is fenestrated at the site of the ulcer, as indicated by the area of staining from the discharge. In addition to fenestrating the stocking, it is my practice to cut the edge of the fenestration in a spoke-like manner, to prevent congestion of the ulcer from the edge of the fenestration pressing into the edge of the ulcer. I have seen many ulcers change from a livid to a rosy hue by merely making these spoke-like incisions into the edge of the fenestration. After the ulcer has been uncovered by fenestration of the stocking in this manner, it is treated by the rubber-tissue-dry-gauze-muslin bandage method described above. Unless it become loose, or very much soiled, the Unna stocking need not be changed for three weeks.

After varicose leg ulcers have been cured, it is important immediately to institute prophylactic methods against recurrence; and for this purpose a well-fitting silk-elastic stocking or a Randolph bandage should be used. Patients should be reminded that in the course of time a silk-elastic stocking wears out and loses its power of supporting the tissues, and that for this reason a new stocking must be purchased at intervals.

To prove the efficiency of the purely mechanical *vs.* the medicament treatment of varicose leg ulcers, I decided to put my method to a severe test by selecting the most extensive case of varicose leg ulcer that I could find. Accordingly, three weeks ago, I began treatment upon a patient whose legs were the seat of chronic multiple leg ulcers. This patient, a man aged seventy-five years, had had the ulcerous condition for about a quarter of a century, and during that extent of time recurrences had been numerous. He reported in the Surgical Clinic of Professor Morris Booth Miller, at the Philadelphia Polyclinic Hospital. From being indolent and sluggishly inactive (Fig. 2), now, after only three weeks of mechanical treatment, the bases of the ulcers are covered with healthy, red, vigorous granulations, while the epithelial edges are bluish-white and rapidly regenerating. When ulcers assume these healthy tints they never fail to heal. The complete epithelialization of some of the smaller ulcers indicates that there has already been established

a tendency to vigorous healing, and that with time and a little patience, complete epithelialization of the largest ulcer may be predicted with certainty unless the ulcer is adherent to bone.

NOTE (January 12, 1916).—Under the above-described treatment the smaller ulcers healed rapidly so that, the skin now being intact, the calomel-adhesive-plaster method was substituted, with a view to curing the two large ulcers, one on each leg. By this method the amount of discharge rapidly diminished, the ulcers quickly assumed the appearance shown in Fig. 1, and the area occupied by the ulcers became markedly decreased.

At present, owing to the adherence of their base to the bone, these two large ulcers, while healthy, seem to have reached a stationary stage in healing; all that is needed for completion of the process of epithelialization is the stimulus afforded by a few Thiersch grafts, which will be applied forthwith. Were it not for the vigorous granulations already covering the bone, the suggestion of C. H. Mayo ("The Preparation of Dry Bony Areas for Skin Grafting," *ANNALS OF SURGERY*, September, 1914, p. 372) could well be applied in this case. (N. 60.)

For an exhaustive paper on other aspects of varicose leg ulcers, consult article by Williams (*British Medical Journal*, July, 1913).¹² 1013.

CONCLUSIONS

1. The rationale of treating varicose leg ulcers is to establish a tendency to heal by combating the pathologic hindrances to healing.
2. The pathologic hindrances to healing are the sequelæ of chronic venous congestion; and chronic venous congestion, in its turn, is the result of the inability of the vena saphena magna and its tributaries to withstand the attraction of gravity upon the long column of blood contained therein.
3. Reduced to its simplest terms, the rational treatment of varicose leg ulcers depends upon the recognition and application of the principles of, first, protection of the regenerating epithelial edge, second, drainage of the discharge from the ulcer and, third, support of the venous channels from without, thus neutralizing the baneful effects of chronic venous congestion.
4. The agents employed in the rational or drugless treatment of varicose leg ulcers may be summarized by terming the method the rubber-tissue-dry-gauze-muslin bandage method. In selected cases the calomel-adhesive-plaster strapping method cures rapidly and efficiently; while for routine treatment of the average case Unna's zinc-oxide-gelatin paste stocking serves as an admirable and efficient support.

TREATMENT OF VARICOSE LEG ULCERS

5. The tendency to healing has been established when the base of the ulcer is covered with healthy, red, vigorous granulations, and when the epithelial edge becomes broader and assumes a pale, bluish-white tint.

6. If in a case of multiple varicose leg ulcers the smallest ulcers become completely covered with epithelium under the influence of treatment, it has thereby been proven that a tendency to healing has been established, and that in time the larger ulcers will heal, if not too large, excessively fibrosed, or adherent to bone.

7. Healing of the ulcers having been brought about, it remains to prevent recurrences. Recurrences may be prevented by mechanical or operative methods: mechanically, by the use of a silk-elastic stocking, renewed when worn out, or by a Randolph bandage; and barking of the shin should be insured against by a shin-guard or wool padding of that part of the stocking that covers the shin. If an operation for excision of varicose veins augurs favorably, it should be performed after healing of the ulcer has taken place; otherwise, the operative wound might become infected from the ulcer, and septic thrombophlebitis, with all the attendant dangers of embolism, might then ensue.

8. The success of the rational, drugless, or mechanical treatment proves the fallacy, as well as the futility, of expecting cure from the application of medicaments, while overlooking the fundamental pathologic etiology of the ulcer.

9. Fads, such as scarlet red and basic fuchsin ointments, do not promote epithelialization of an ulcer without due regard for the pathologic etiology of the ulcer, and when regard for this factor has been taken into account, the use of such stimulants is unnecessary.

THE ARTIFICIAL PERIOSTEUM FOR FIXATION OF SHAFT FRACTURES*

BY JOHN B. ROBERTS, M.D.

PROFESSOR OF SURGERY

(Note from the Surgical Laboratory of the Philadelphia Polyclinic.)

THE ease with which subperiosteal fractures are cured with little callus and slight deformity is nature's hint as to treatment. Surgeons have been misled into thinking that the essential factor in treatment is absolute immobility of the jagged bone ends. Therefore, prolonged immobility by means of external splints or direct fixation by plates has successively been the vogue.

When the periosteum is little torn or only slightly stripped from the bone's shaft, reduction of the fragments and retention of the broken surfaces in apposition are easy of attainment. Successful reconstruction of the skeleton follows readily. What shall be done, however, under reverse conditions, namely, greatly lacerated periosteum, consequent wide separation of fragments, and, perhaps, entanglement of the jagged pieces of bone in muscles and fasciæ? Inspect the broken bone, repair the periosteum or provide a new periosteum, and give stability and rigidity by means of traction and contour-fitting splints.

The only way to repair the torn periosteum is to expose the broken bone by aseptic incision, adjust the ends of the fragments, and stitch the ruptured fibrous covering around the break. Often a firm repair of the periosteum in this way is not possible. Why not then substitute a graft of the fascia lata, cut from the outer surface of the patient's thigh; and, by wrapping it around the shaft of the bone at the seat of the break, prevent lateral displacement or overriding? The operative wound should then be closed without drainage and a gypsum encasement, with or without continuous traction, be adjusted to the limb.

This method I believe will be found a valuable improvement over the plating of rebellious fractures of the shafts of long bones. I have only experimented with fascial tubes or straps for this purpose on the cadaver.

The success of D. C. Straus¹ with woven catgut rugs or splints in treating experimental fractures in dogs has, however, convinced me of the value of his method of support. The autogenous fascial graft is

* Read before the Philadelphia Academy of Surgery, November 1, 1915.

¹ Surgery, Gynecology and Obstetrics, October, 1914, p. 410.

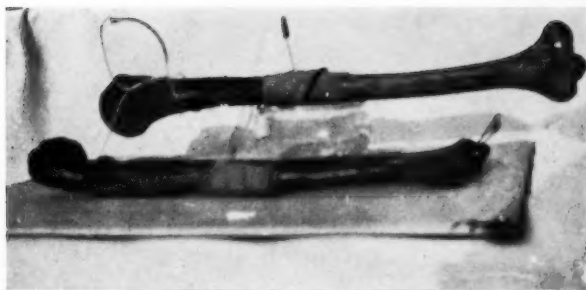
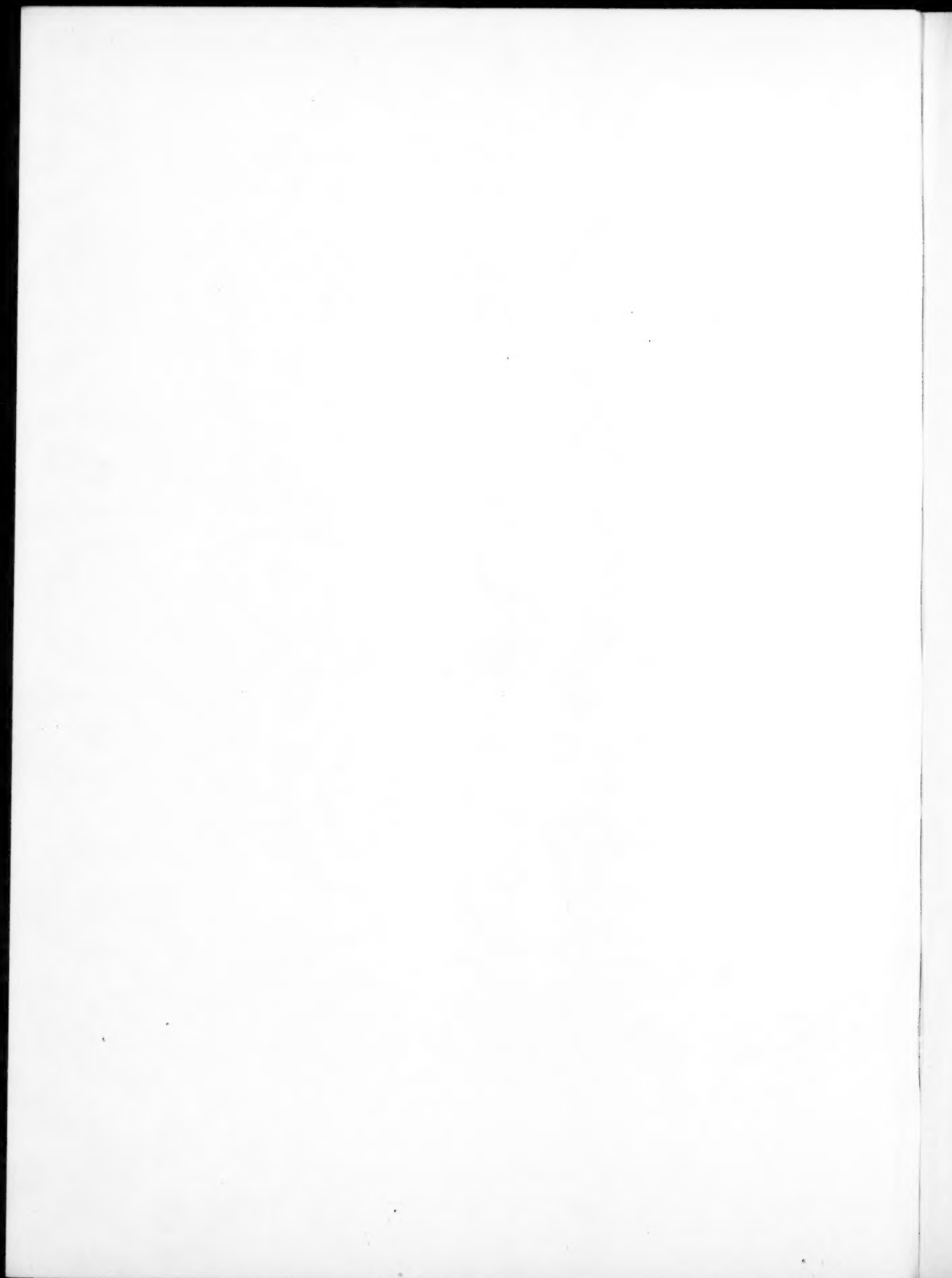


FIG. 1.—Model of fracture of humerus supported by an autogenous tubular sheath of fascia lata acting as an artificial periosteum. At the upper end of the humerus is seen the flat curved needle and catgut thread, by which the sheet of fascia has been carried around the broken bone after the fracture has been made accessible by incision of soft tissues. Bones of forearm showing fracture of ulna supported by a fascial wrapping representing an autogenous artificial periosteum.



ARTIFICIAL PERIOSTEUM IN SHAFT FRACTURES

founded on the same mechanical principle, which is that a firmly placed tube or wrapping of flexible tissue around a broken rod or bone prevents displacement.

Macewen has insisted that the periosteum does not generate bone, but merely limits its growth. If this be true, placing a new fibrous envelope, instead of the lacerated fibrous periosteum, around the ruptured osseous tissue restores in some degree the normal status of the injured bone. A long piece of fascia lata wrapped twice about the replaced fragments will, if firmly bound by sutures of fascia or of catgut or tied by strings of the same absorbable material, prevent shortening, alteration by rotation and lateral displacement. Later it will either be absorbed or converted into a sheet of fibrous tissue similar, mechanically at least, to periosteum. Normally the periosteum gives toughness and elasticity to the bone. The fascial envelope acts somewhat in a similar manner.

Thus the fascial tube is, I believe, preferable to metal plates. In comminuted fractures of the shaft it would seem to be greatly superior mechanically to plates, screws, nails, inlay grafts, or bone pegs. Straus's catgut mat was absorbed in dogs in three weeks. It is possible that stomach wall or bladder wall of the lower animals or real parchment might be used instead of the patient's own fascia lata. My experience with autoplasmic grafts, however, and the ease with which a long strip of fascia lata can be taken aseptically from a patient's thigh, without real risk to him, cause me to prefer its use.

It is possible that other surgeons have suggested fascial tubes or straps for steadying or fixing fractures requiring open or blood-letting treatment. If so, I have not heard of their experiments or experience. I should be glad to hear reports from the Fellows of the Academy, if they adopt the procedure for cases to which it seems applicable.

There have been various endeavors to obtain absorbable fixation appliances instead of plates. This seems to be the simplest.

If there is too much flexibility at the seat of fracture after the fascial binding, one of my fracture drill-pointed nails, described before the British Medical Association at Edinburgh in 1898,² may be driven through the fascial tube into the bone ends to steady them and its shaft be allowed to protrude through the closed wound. It may be readily removed at the end of ten days or two weeks without important disturbance of the external dressings.

An artificial periosteum is adapted to fracture thus:

² Philadelphia Medical Journal, 1898, and Notes on the Modern Treatment of Fractures, D. Appleton Co., New York, 1899.

The broken bone is exposed and freed from muscles for two or more inches. The fascial graft, cut from the outer aspect of the thigh, should be six or more inches long. One end should be pointed. To this pointed end should be tied, or sewed with catgut or fascia, a cord of thick catgut or Kangaroo tendon or a band of fascia. This cord should be threaded into a very large, flat, curved needle, like that used to carry a Gigli or chain saw around a bone. By means of the needle it is easy to draw the fascial graft around the coapted fragments so as to wrap the bone twice or thrice. The wrapped graft is then smoothed out on the surface of the bone and the cord used to fix it close to the enclosed broken shaft. One or two stitches may be made with the needle into the layers of fascia; or another absorbable thread may be used to stitch down the end and fasten the edges of the wrapping together. The muscles are then allowed to fall into place, the fascia over the muscles is sutured and the wound closed without drainage, as in Lane's method of plating. Outside is applied a gypsum-gauze encasement with or without traction, or a simple form of splint is used to give rigidity and secure protection from injurious motion.

The use of fascia may be varied somewhat. In very oblique fractures, for instance, two quite narrow splints may be wrapped about the bone at a considerable distance from each other and, if continuous traction is used, coaptation of fragments and length of bone will be preserved.

This fascial tube, or artificial periosteum, apparently solves the problem of substituting absorbable for non-absorbable support in shaft fractures. In 1911, I prepared, on invitation from the officers of the French Congress of Surgery, a paper entitled "An American Surgeon's Opinions of the Open or Operative Treatment of Closed Fractures." As I was, however, unable to attend the meeting it was published in *Archives Internationales de Chirurgie*, vol. vi, page 62. I have not since changed my opinion that the bloodless methods of dealing with fractures ought to remain the usual choice, and that they give, in the hands of those who apply them with care, good results. This view was and is the same that was taken by Robert Jones of England in his review of the Report of the Fracture Commission of the British Medical Association, and was that of the late Professor Bardenheuer in Germany, who for years insisted upon the infrequency of blood-letting operations if fractures were treated by permanent extension. Many surgeons in America hold the same opinion. When operative attack, however, is needed I believe the fascial tube or strap will often be found to answer the purpose better than the metal plate for shaft fractures.

HOMOPLASTIC TRANSPLANTATION OF A BOILED SEGMENT OF A RADIUS

RESULT AFTER THREE AND A HALF YEARS

BY CLARENCE A. McWILLIAMS, M.D.

OF NEW YORK CITY

ASSOCIATE SURGEON TO THE PRESBYTERIAN HOSPITAL

THROUGH the kindness of Dr. George E. Brewer, of New York, I am enabled to report this case, which he operated upon at Roosevelt Hospital on January 27, 1912. The patient was a man of twenty-seven years of age, who complained of a painless lump on the flexor surface of the right forearm. Röntgenogram showed that the lower portion of the radius was involved in a tumor growth. At operation the tumor was found to be covered anteriorly by a thin shell of bone and it consisted of a spongy mass of rather soft vascular tissue, in a cavity lined by a smooth wall of dense bone. Microscopical examination showed it to be a giant-celled sarcoma. An excision of the entire lower $2\frac{3}{8}$ inches of the radius, with its periosteum, was performed and the soft parts were sewn together about the defect. Two days later an adult pistol-wound suicide was brought into the hospital and from his radius was removed a piece of bone of exactly the same length as that which had been removed. This bone was boiled for an hour and then kept in sterile salt solution for four days, when the original wound was reopened and the boiled homoplastic radius was inserted in the defect, which it accurately filled up. It was not sutured in place but simply laid in, and about it the soft parts were accurately sutured. A plaster splint was applied. The patient was followed for a year and a half and röntgenograms were taken at different periods. The graft healed in perfectly by primary union and there has never been any discharge from it. The pictures showed some honeycombing of the graft and some bowing of the forearm.

The result was supposed to have been good until the author, in his zest for bone grafting cases, located the man after some search and elicited the following röntgenogram. The hand is much radially abducted, in fact there is a well-marked dislocation of the hand on the ulna, which latter can be distinctly palpated. The function of the hand is much injured, there is almost no abduction, and flexion and extension of the wrist are slight. The grasp of the hand is very weak. The röntgenogram is very interesting. The entire graft (*D*) can be roughly divided into three sections

(*A, B, C*). *C* is that portion of the graft which has been completely and perfectly regenerated and is thoroughly united to the old bone at *E*. *B* is that portion of the graft which has incompletely been regenerated, while *A* is that part of the graft which has been completely absorbed with no attempt at reformation of the bone in the slightest degree. The time elapsed since the operation has been over three and a half years, it is safe to say that the regeneration of bone has taken place as much as it ever will, so that we may regard this as the permanent result. Several things are evident at once—first, the result of this transplantation speaks for the value of contact with living bone, for section *C* is so perfectly regenerated because of its immediate contact with living bone at *E*. Section *B* is farther away from living bone, and as a result the new bone is only partially regenerated, being honeycombed, while section *A* is farthest away and shows absolutely no regeneration of bone after absorption of the original dead matrix, the distance away from the old live bone being evidently too great to produce new bone. It would seem reasonable to suppose that had there been live bone impinging on the carpal side of the graft the whole graft might have been regenerated. This transplantation then bears out Murphy's idea of the value of contact certainly in dead homoplastic bone graftings. That the new bone did not come from the *surrounding* connective tissue is evidenced by the progressive lessening of its formation as one proceeds towards the hand. Had this connective tissue a great influence in the formation of the new bone, then there should be as much new bone formed in section *A* as in *C*, whereas the fact is that in section *C* the new bone formation is perfect while in section *A* it entirely fails. It seems reasonable then to assume that the new bone in *C* was formed through the growing into it from the old, live stump of blood-vessels which penetrated a certain distance thoroughly and then these gradually faded out, producing less and less bone as they advanced. A better method to have employed at the time of the original transplantation than this homoplastic grafting would have been to transplant a corresponding section of the patient's own fibula with its periosteum, the upper articular fibula extremity impinging on the carpus.

To correct the present dislocation seems now to be the main indication of treatment. To do this all that would be necessary would be to resect a sufficient amount of the lower end of the ulna, which would allow of the straightening of the hand.

Homoplasty.—Homoplastic bone transplantation is the grafting of bone from *another* individual, of the same species, into the person who is to be grafted. The graft has been transplanted either living or dead.

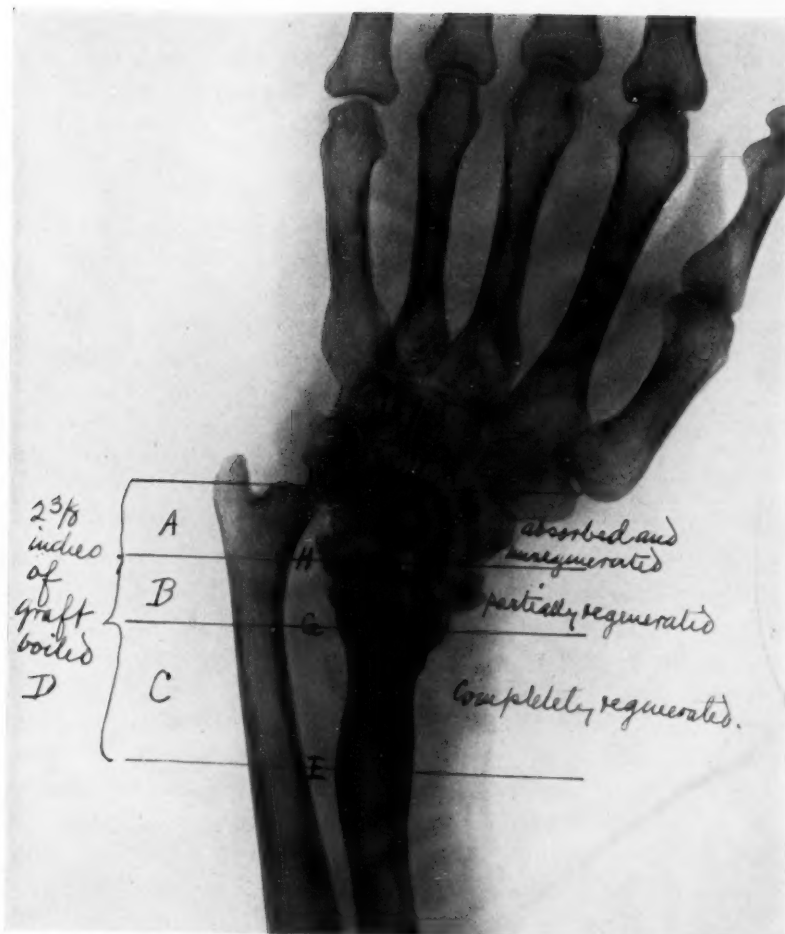


FIG. 1.—*D* is the $2\frac{3}{8}$ inches long, boiled, homoplastic transplant after three and one-half years. *C* is the completely reformed adjacent section, consolidated at *E* with the old, live stump. *B* is the but partially reformed segment, osteogenesis apparently beginning to fail. *A* is the segment in which the old dead bone matrix has been entirely absorbed and there is no reformation of new bone in this section, osteogenesis having entirely given out.



HOMOPLASTIC TRANSPLANTATION OF RADIUS

Dead human bone, just as animal bone and foreign material, plays the rôle of an internal prosthesis rather than that of a true graft. It simply furnishes a conductor, a matrix for the periosteal regeneration of bone coming from the neighboring, living old bone. How much exciting or stimulating influence dead bone will have on this formation of new bone is questionable. The graft can certainly furnish no new bone of itself. This form of dead bone transplantation has largely been given up for good reasons. Homoplastic bone grafts are far inferior in results to autoplasmic bone grafts; but if they should be used, the grafts should be taken *living* from another individual and always *with* periosteum. In transplanting joints, it will be necessary to make a homoplastic transplantation. To obtain a living graft, it will be consequently necessary to obtain it from a fresh amputation or from a cadaver soon after death.

The success of such a living graft will depend on the serological relations between the individual from whom the graft is taken and the individual into whom the graft is to be transplanted. For in the one case the bone is originally laid down in serum of a certain composition. Bone from this individual may be transplanted into an individual whose serum may be of somewhat different composition, hence the graft will be foredoomed to more or less chemical change. The chance for success of such a graft in homoplasty will be just about in the same proportion of success as will be attained in attempting to find two bloods in blood transfusion which will agree and not hæmolize when mixed. This is advanced as a more or less theoretical suggestion. Certainly bones from different individuals have probably different chemical compositions and the chance of grafting, from one individual into another, bone of exactly the same composition would theoretically appear to be doubtful, resulting in cytolysis. In addition, the danger of sepsis and transmitting disease as well as the inconvenience of waiting for a corpse or an amputation from an assured healthy individual have caused this method to be almost given up. Homoplastic transplants have occasionally been successful, but not as many of the osteogenetic cells remain alive and actively proliferate as in autoplasmic grafts; hence the formation of new bone is slower, and its extent is less, consequently it is more uncertain as to its ultimate success.

The following instances of both living and dead homoplastic bone transplantations I have come across in the literature. The results must in many instances be taken *cum grano salis*, since many were reported as successful which, had a greater time been given, would have proved far more successful. The results are given, however, as reported.

CLARENCE A. McWILLIAMS

(a) LIVING HOMOPLASTIC BONE TRANSPLANTATIONS

KUTTNER resected the upper third of a tibia for malignant chondroma in a man aged forty-five. The resected bone was replaced by a fragment of a tibia taken from a cadaver 27 hours after death. This graft was very well tolerated. The patient has a movable knee and can walk.

A successful case combining a heteroplastic transplantation of a kid's bone with a homoplastic graft from an asphyxiated new-born foetus is given by PONCET.

LEXER replaced the upper humerus end, including joint surface, by a piece of a freshly amputated femur. Good result.

FRANGENHEIM reports 4 cases of dowelling with homoplastic material.

V. HABERER resected two-thirds of the upper arm and filled the defect with a periosteum-covered fibula freshly obtained from an amputation. Primary union, and the arm in 5 months fully functionated.

BAUM implanted into 4 cases of pseudarthrosis, twice bones of freshly amputated extremities, and twice fetal bones. All four cases gave negative results.

ANSCHUTZ achieved a relative good result in a 7 cm. long congenital tibial defect, which had been autoplastically grafted several times with no success, by transplanting bone from a perforated foetus. A second smaller attempt with the bone of a 7 months' foetus was unsuccessful.

OLLIER replaced the totally necrosed ulna by a bony piece obtained in a fracture operation. After 5 months the transplant was absorbed.

PONCET filled the defect in a pseudarthrosis of the tibia by half the first phalanx of an amputated great toe. No consolidation. He then transplanted bony pieces taken from a child asphyxiated at birth. These were extruded.

SAMTER in an osteomyelitic total defect of the tibial diaphysis transplanted a pedunculated periosteal bony flap, which led to very small new bony formation. He then implanted a 14 cm. long cadaver bone, which after some time must again be removed. Final consolidation.

BARTH reports the implantation into a tibial defect of a piece of bone without periosteum taken from a freshly amputated leg. Resorption without consolidation. He also reports a case of ununited fracture of left leg. A graft of a piece of bone without periosteum was taken from a fresh amputation. Absorption of graft without consolidation.

GROSSE, of Halle, reported a case of pseudarthrosis of the tibia. Implantation of a fragment from a fresh amputation in an adult. Consolidation in a year between the fragments and the graft. Radiographically demonstrated. The graft appears to have undergone complete reorganization and the child can walk well. This case was reported 12 years after the transplantation by Stieda, who says that the graft now cannot be differentiated from the old bone. The child limps because of the shortness of the limb due to the destruction of the epiphyseal cartilage.

ROBERTSON resected the lower ends of radius and ulna for sarcoma. Implantation of radius and ulna with periosteum from a fresh amputated arm, the radius being wired. Amputation 12 months later because of recurrent tumor. Examination showed obliteration of the wrist-joint by fibrous tissue, also that the grafts were living. There was some motion between the fragments.

HOMOPLASTIC TRANSPLANTATION OF RADIUS

MORRISON reports removing the diaphysis of a tibia for osteomyelitis and transplanting a portion of a fibula taken from a fresh amputation. Six years later the leg had to be amputated on account of a failure to grow and of deformity. The foreign fibula was not more than a third of the size that it was when the operation was done.

KUTTNER transplanted into the defect caused by the resection of the superior extremity of the femur for sarcoma, an equal upper extremity of a femur removed from a cadaver 3 hours after death. This fragment was well tolerated. There were two local recurrences which were operated upon with success. Later, at the end of 7 months, the patient suffered a spontaneous fracture at the point of union of the dead bone with the old bone. This fracture *consolidated* and the patient had a very satisfactory function of his limb. Kuttner attaches great importance to this consolidation of the fracture and he thinks "that it shows better than any other proof could, that the bony graft had been truly alive."

STUCKEY reports a case of pseudarthrosis in the middle third of the tibia. Osteoperiosteal skin-flap with base external was taken from the upper fragment. Fragments were freshened and the marrow removed. A dowel of a portion of the entire thickness of a fibula without periosteum was taken from an amputated leg. The dowel was 11 cm. long. Its narrow canal was filled with iodoform plug and it was placed in the medullary cavities of the fragments and over this the osteoperiosteal flap was fixed with the same periosteal silk sutures. Complete consolidation in 90 days. Nine months after the operation the patient fell and fractured the graft, but this soon healed. A curved deformity resulted which had to be remedied by osteotomy. Was not this new bone formed from the old periosteum?

TERMIER resected the inferior half of the radius for sarcoma. He implanted into the defect sufficient of the fibula taken from an amputation made a few minutes before; primary union. For nine months he followed the gradual incessant destruction which by "lacunar corrosion and decalcification" produced a gradual and complete disappearance of the graft. Termier concludes that the pretended osteogenetic property of the graft does not exist, and that cytolytic and progressive absorption are almost the rule for transplanted foreign tissues.

ROVSING replaced the lower part of the femur, which he had resected for sarcoma, by a section from an old humerus, sterilized with care. The result was bad because the graft broke and there was no consolidation. He waited until he amputated a leg and took a section from the femur which he implanted into the defect 20 minutes after the amputation. A year after the grafting, there was a small fistula upon the inferior surface of the thigh. The patient has resumed his occupation as a vender and gets about on two canes, the limb being strengthened by a leather apparatus.

MACEWEN in his book mentions a living homoplastic transplantation in a boy, the whole of whose diaphysis he was compelled to remove for necrosis. There was no subsequent osseous deposition. Fifteen months later he was re-admitted with the request by the parents that the boy's useless arm be removed. Two wedges of bone were excised from another patient of six years of age afflicted with anterior curves. These were cut into minute fragments, quite irrespective of the periosteum, and were then deposited into the muscular sulcus

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in the boy's arm. There was no pus formation. Two months later a portion of new bone, an inch in length and three-quarters of an inch in thickness, was found firmly attached to the upper fragment of the humerus. Here all the grafts proliferated, grew to one another, and also to the extremity of the proximal portion. Two other wedges of bone of larger size than the first were similarly dealt with and inserted two months subsequently to the first graft, and a third couple were placed in position five months after the first. These all fused together and to the condyles of the humerus, filling the gap in the arm to the extent of $4\frac{1}{4}$ inches. It is now 30 years since the humeral shaft was rebuilt, and during all this time the man has depended upon his physical exertions for the earning of his living. He worked as a joiner for many years, and is now an engineer's pattern-maker.

TROUT reports a very successful transplantation of a section of a father's tibia into a spina bifida of his child.

(b) DEAD HOMOPLASTIC TRANSPLANTS EITHER BOILED OR IN ANTISEPTICS

V. BRAMAN implanted into a humerus defect a 16 cm. long piece from the fibula which was boiled for two hours. Successful result.

FRIEDRICH resected the entire right femoral diaphysis and implanted a dead fibula from a tuberculous boy; good result. He resected also 12 cm. of the femoral diaphysis. Into this defect was implanted a boiled 17 cm. long femoral diaphysis of a sixty-five year old man who died of carcinoma. Perfect healing in of implant.

FRANKE implanted into a resected defect of the carpus, dead bone. No result. Then autoplasty from the tibia with good result.

KAUSCH in 1906 reported up to this time the greatest case of implanted dead bone which healed in the tissues. A 9 cm. long piece of the whole diameter of a tibia was obtained the day before from an amputation. It was boiled and then implanted between the resected tibial and femoral ends, these being held by ivory pegs. Primary union. After three-quarters of a year recurrence. Amputation. Autopsy showed good healing in of transplant, which was surrounded by new-formed periosteum. Case 2: Pseudarthrosis of the tibia. Implantation of a freshly-obtained phalanx from a previous operation. This was boiled. Fistula developed. Removal of implant. Case 3: Sarcoma of the upper arm. Implantation of two sterilized cadaver humeri. Removal of the same after 5 months on account of fistula formation. Case 4: Sarcoma of the upper arm. Resection. Implantation of a freshly-obtained cadaver humerus which was boiled for an hour. Removal after one month on account of infection. Case 5: Sarcoma of the internal femoral condyle. Oblique resection of this condyle. Implantation of an old anatomical lower femoral bone which was boiled. Removal of the same on account of purulent secretion on the eighteenth day. Case 6: Sarcoma of the lower femur. Implantation of a boiled anatomical department bone. Removal on account of infection.

GROSSE implanted in a pseudarthrosis of the tibia, a living exostosis from a ten-year-old girl. Primary union but absorption of the graft. The same result occurred after implanting a section from an amputated ulna without periosteum. Then complete consolidation occurred after the implantation of a boiled piece of a tibia without periosteum from an amputation. Eleven years afterwards the röntgenogram gave a single shadow of the tibia.

HOMOPLASTIC TRANSPLANTATION OF RADIUS

STIEDA implanted in a pseudarthrosis of the arm of a girl, a 16 cm. piece of a boiled fibula from an amputation. After a year there was a pseudarthrosis at the upper end of the implant. There developed fistula with final sequestration, compelling the removal of the dead implanted fibula.

KUTTNER resected, in a man thirty-one years of age, the entire upper extremity of the femur for sarcoma. He replaced the segment of resected bone by the upper extremity of a masculine femur, taken aseptically 11 hours after death from a cadaver. This segment was preserved for 24 hours in Ringer's solution with added chloroform. The dead femur was united to the remains of the healthy femur by an intramedullary ivory dowel and the tendons were united to this graft so far as possible. Death occurred 13 months later from metastases. Autopsy of the graft showed perfect insertion of the muscular tendons of the bone into the dead graft. The functional result besides was very good and the patient, 6 months after the operation, could make numerous movements of the hip. The microscopical examination of the fragment of the dead graft showed that it was "little living," and it is very probable that this dead bone was simply tolerated as an aseptic foreign body. Its utility had been considerable since new muscular insertions were made on its surface and functionally it fulfilled its rôle.

STREISSLER reports a case of comminuted compound fracture of both bones of the leg, resulting in a defect of 5 cm. in the tibia, and with overriding of the fibula fragments. After several months the granulating wound was opened, the tibial ends were freshened and the attached fibula ends separated. A 10 cm. long section from a tibia of a fresh amputation was taken and was boiled for 20 minutes in soda solution. The graft was then dowelled into the upper and the lower medullary cavities and fixed by silver sutures. The granulating surface soon became closed in. Progressive radiograms showed lacunar erosions of the graft with gradual absorption. The upper tibial fragment became consolidated with the lower fibula fragment. Final removal of remains of the dead graft. The fibula gradually increased to three times its normal dimensions, and bore the whole body weight.

In conclusion the author desires to express his indebtedness to Dr. Brewer for the privilege of reporting his interesting and instructive case.

A SYMMETRICAL CONGENITAL MALFORMATION OF THE EXTREMITIES

WITH A REPORT OF TWO CASES*

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CONGENITAL abnormalities have lately been studied with much greater interest than previously. The subject is of special interest to biologists. The patients with such congenital abnormalities are no more shown before medical meetings as mere cases of interest or for exhibition of the skill of the operating surgeon, but they are demonstrated with an interest of study. They are usually considered normal conditions of organisms in an inferior state of development. Since the work of Abbé Mendel, showing the theory of heredity, became more widespread, many of these incidents have been explained. There are still many cases which are ascribed to pressure by amniotic bands on the ossification centres, as Jansen¹ has excellently brought to light in his monograph on achondroplasia. His conclusions are: "The amnion has the power of destroying deep-lying parts in a perfectly normal embryo either with or without a simultaneous injury to the skin, and this destruction is most easily effected when the extremities are still composed of scleroblastema."

The only way in which the etiology of these cases may be cleared up is by having them reported by their observers. When the student in biology or anatomy, who is better equipped for such studies than the surgeons, tries to analyze the nature of the abnormalities, the reported cases will be at his disposal and thus he will be able to avail himself of them.

Keibel and Mall,² discussing abnormalities in the development of the skeleton, state: "The form of the skeleton as a whole and of the individual bones which compose it, depends partly upon heredity, partly upon the mechanical and chemical influences to which it is subject during growth. The variations which are a normal inheritance of the race, including such extreme forms as individuals with six fingers or six toes, are to be distinguished from the abnormalities of structures due to unfavorable environment either within or without the body.

* Cases presented before Section on Orthopædics in New York Academy of Medicine, February 19, 1915.

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The skeletal lesions vary all the way from a retardation in the time of appearance of centres of ossification to the failure of a part of the skeleton to develop."

That heredity plays so important a part in the primal origin of these deviations from normal, can be shown by comparing them to plants and lower animals. Castle³ says: "Every breeder of animals is familiar with the complexity of hereditary processes. Characters of the most varied sort are inherited. These relate not only to general size and proportion but also to the structure of the individual parts and functional peculiarities." Burbank⁴ says: "In plants you can breed in any single desirable attribute which is lacking there. Choose what improvements you wish in a flower, a fruit or a tree, and by crossing, selection, cultivation and persistence, you can fix these desirable traits irrevocably. There is a distinct similarity between the organization and development of plants and human life."

In reporting cases of abnormalities in human beings, the observer must, while taking the history and also while examining the patient, bear in mind the facts to be observed as mentioned by the authorities quoted. Thus more uniform reports for the help of the biologist may be obtained.

In trying to look up the literature on congenital abnormalities of the extremities, one finds that polydactylism was quite frequently reported, while shortening of the metacarpals and metatarsals is not so often recorded. Even Dwight⁵ in his excellent atlas (of variations of the bones of the hands and feet) does not go into great details about short metacarpals or metatarsals. He states: "There is a long type and a short type of metacarpal variation. The short is more important, as it is often at least one-half of the ordinary length. Two or three fingers may be affected in one or both hands though without perfect symmetry." He records only one case showing shortening of the fifth metacarpal and calls it a remarkable incident. He mentions nothing about metatarsal shortening. There were surely more patients with such abnormalities seen by the surgeons, but it seems that these deformities do not strike the eye as polydactylism and thus it is either unobserved or considered not of great importance. Day⁶ reports one case of symmetrical short metacarpals as unique. I have not made, however, a careful search for such reports (leaving this task to the anatomists), but am under the impression that only a small number of individuals with short metacarpals or metatarsals are on record.

Though I have nothing new to offer, I feel that I am justified in reporting in detail the two cases which came under my observation

with short metacarpals and metatarsals. These may aid the studies of the etiology.

CASE I.—M. L., female, aged thirty-five, consulted me for pain in her feet. Examination showed a plain case of double weak feet. On inspection, I discovered that the fourth toes of both feet were shorter than normal. While I was trying to find where the defect lay, the woman voluntarily offered the information that the deformity was congenital and that both hands showed exactly the same peculiarity. The hands really presented shortening of both ring fingers, the tips of these were on the same level with the tips of the little fingers, and the knuckles of the ring fingers were on a higher level than the knuckles of the other digits. There was no complaint of weakness of the hands and the muscular power was normal.

On inquiry into the hereditary history she told me that her two sisters, an uncle, an aunt, her grandmother and four other members of the family showed exactly the same defect, and that was the reason why she never worried about the unsightly appearance of her finger on which she wore her marriage ring. She said that there might be some more relatives with the same deformity, but she was not acquainted with them.*

X-rays (Figs. 1 and 2) showed clearly the shortening of the fourth metacarpals in both hands. The fourth metatarsals are also shorter than normal.

Remarks.—To discuss the origin or the cause of this particular deformity, we will quote here the statements of the authorities Keibel and Mall,² who give the following conclusions: "Agenesis or failure of skeletal development may be due either to primary lack of origin of a part or to an affection which destroys the skeleton anlage after it has begun to differentiate. It is found more often in the vertebræ, less often in the bones of the extremities. Hypoplasia or under-development of the skeleton, whether generalized or confined to a part, may be due either to prenatal or to postnatal conditions. The failure of the bones to develop normally may be due (1) to lack of active proliferation of cartilage (characteristic of cretins), (2) to inactivity of the process of ossification, (3) to a premature union of epiphysis with the main part of the bone, (4) to growth of connective tissue between the growing cartilage of a bone and the region where ossification usually

* At the time when the patient was examined, I did not consider the case of sufficient interest to make out a careful family tree. When, later on, the second patient came to me, I reminded myself of the first, and have written to her but have not been able to find her, as she left the city. I suppose that in a similar way many such cases are unreported by the observing surgeon.



FIG. 1.—Radiogram of Case I, showing the short fourth metacarpal of the right hand.



FIG. 2.—Case I. Left hand, showing the same deformity.

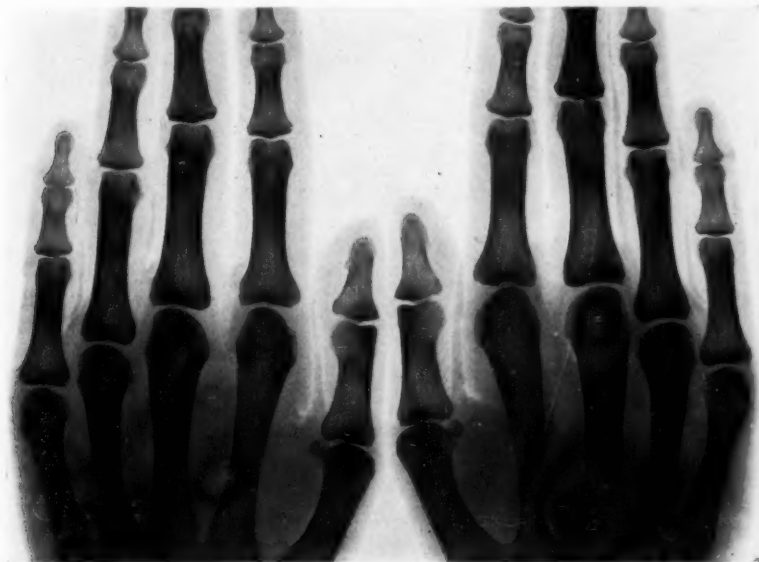


FIG. 3.—Case II. Radiogram of both hands, showing the symmetrical shortening of the fifth metacarpals.

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CONGENITAL MALFORMATION OF EXTREMITIES

extends into the cartilage (micromelia, chondromalacia, fetal rickets), and (5) to inflammation and other abnormal conditions affecting the growing parts of the bone." We cannot by examining such a patient tell what this particular hypoplasia is due to, but we can discuss it from a general view.

Here we will recall the early embryology of the extremities. I will refer to Bardeen⁷ and Lewis⁸ who by careful studies showed that the arm bud occurs in the fifth week, while the leg bud or anlage of the leg occurs later (about the sixth week). The cartilages which are supposed to make up the metacarpals and the metatarsals show at the sixth week, while at the seventh week the limbs begin to resemble those of an adult.

Even before obtaining the family history, we can assume that the condition in my patient is due to primary lack of origin of the anlages rather than to an affection which destroys the skeleton anlages after it has begun to differentiate. Since both fourth metacarpals and metatarsals have similarly been affected, we conclude that the underlying cause lies in the origin rather than in later affections. For there is no probability of having two external influences on two different structures (arm and leg buds) which, as has been mentioned before, do not originate at the same time.

Where the exact fault lies cannot, of course, be determined, but as such patients give a distinct hereditary history, we can assume with safety that there will be some more members born with such embryonic defects. Should there be some miscarriages in some of these families, the foetus could be examined by competent embryologists and probably the exact location of the origin could be found. I think that only by such studies can the etiology be cleared up.

CASE II.—A. F., female, aged nineteen, came to me complaining of cold feet which on examination was shown to be due to poor circulation with low arterial pressure. On examination of the upper extremities, the little fingers were found to be shorter than normal, the tip reaching to about the middle of the middle phalanx of the ring finger. There was nobody in her family who had a similar deformity. X-ray showed shortening of the fifth metacarpals (Fig. 3).

Remarks.—Though one would at first hand consider that the short fingers were due to amniotic pressure in view of the fact that the lower extremities had also poor circulation; still, when we note the exact symmetry of the deformity in both hands, we must put the blame on some developmental defect.

On inquiry into the family history, her mother, in trying to explain the cause of the defect, voluntarily offered the well-known explanation that it was due to some bad mental impression received by her during pregnancy (telegony). This is not the place to explain that telegony cannot cause such a deformity. According to her statement, the impression was received when she was three or four months pregnant, while, as we have mentioned before, the hands have all the characteristics of an adult at about the sixth week and thus deformity must already have existed at the time of the supposed impression. The impression to be a real factor must be within a few days of conception, and usually a woman is not aware of her pregnancy at such an early period. Harrmann⁹ has called attention that there may be some grand maternal impressions which cause deformity. It is well known to poultry raisers that it is necessary to take extra care to avoid shocks on opening and shutting the drawers of the incubators. A child can therefore be born, who bears no outward and visible sign of an inward and germinal blot received through telegony. Yet should this child in its turn become a parent, its child may be marked within and without. Within by carrying on the defective germ plasm, and without by the defective organ represented by that inward germinal defect. That defect will be carried on from generation to generation until some more dominant type overrides and ousts the characteristic defects.†

CONCLUSIONS

1. Symmetrical defects of metacarpals and metatarsals are occasionally found.
2. Bilateral congenital malformation can generally be traced to heredity, while a unilateral congenital malformation may be explained on principles of embryonic pressure defects.
3. Cases of hypoplasia and agenesis should be reported with the same accuracy as polydactylism, and thus some new light may be thrown on the subject.
4. Stillbirths, born in families having some defects in bones, should be examined by an embryologist to find whether their embryological structures are normal.

† I have lately come across a patient who had a short fourth metatarsal of the left foot. Nobody else in the family had a similar affection. Thus this deformity can probably be traced to some external influence. There are many patients who come to the orthopaedist for flat-feet with one short toe and no notice is taken of the deformity. I can recall having seen many such cases. It is the symmetry that is more observed and ought to be reported accurately.

CONGENITAL MALFORMATION OF EXTREMITIES

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PERITONEAL ADHESIONS: THEIR PREVENTION WITH CITRATE SOLUTIONS

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THIS report gives the results of experiments with hypertonic solutions of sodium citrate and sodium chloride, used in the hope of preventing post-operative adhesions in the abdomen. The work was suggested to the author by an article by Dr. Saxton Pope, of San Francisco, entitled, *The Use of Citrate Solutions in the Prevention of Peritoneal Adhesions* (ANNALS OF SURGERY, January, 1914).

All the experiments were performed on rabbits under ether anaesthesia, using ordinary surgical precautions against infection; number of rabbits operated upon, 63; number of operations, 104.

Formation of Adhesions.—The first step was to find a sure method of causing uniform adhesions.

It was found first that any procedure which caused injury to the peritoneum, great enough to produce the death of cells, was followed by the formation of adhesions. The greater the destruction of peritoneum, the more adhesions there were. The presence of infection with ordinary pus-producing bacteria invariably caused dense adhesions.

The densest aseptic adhesions were caused by touching the peritoneum lightly in five places with a small gauze pledget, dipped in half strength tincture of iodine. Dry gauze packed about the colon for ten minutes caused adhesions. Scratching the colon in many places over its proximal two to three inches, the scratches going through the serosa down to the submucosa, invariably caused firm adhesions. This technic of scratching the colon, being easily duplicated and sure in its results, was used in all the experiments reported below on the prevention of adhesions.

Pathology of Adhesion Formation.—Much work was done on the histology of adhesions, specimens of adhesions being taken at various stages in their development, and paraffin sections made. Good sections were secured of adhesions taken 1, 2, 4, 5, 6, 7, 8, 10, 11, 12 and 15 days after operation, and these were studied histologically for the development of adhesions.

The process is simply that of healing, as found anywhere in the



FIG. 1.—Adhesions after two days ($\times 130$ diams.). A mass of fibrin with a few cells.

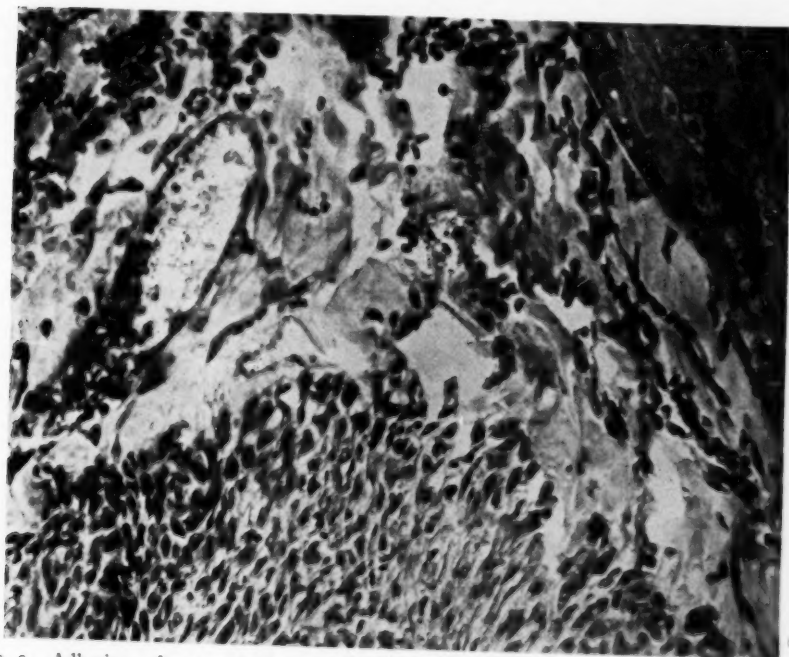


FIG. 2.—Adhesions after two days ($\times 375$ diams.). Beginning organization—fibroblasts and new blood-vessels reaching out into the mass of fibrin.

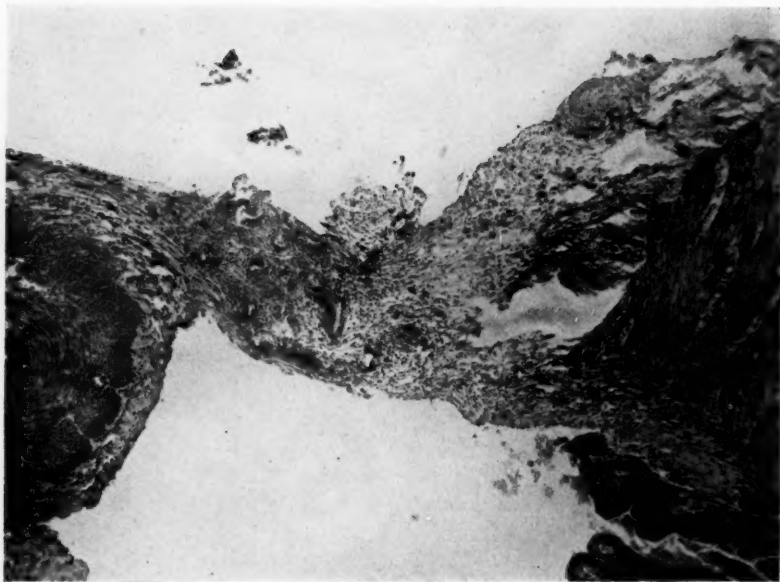


FIG. 3.—Adhesions after six days ($\times 40$ diams.). Organization nearly complete.

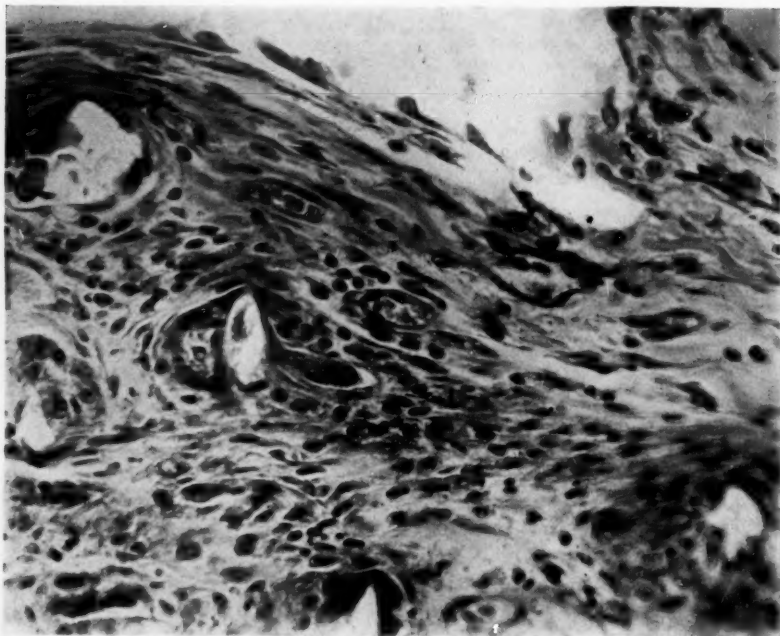


FIG. 4.—Adhesions after six days ($\times 375$ diams.). Organization advanced—peritoneal cells proliferating to cover adhesions.

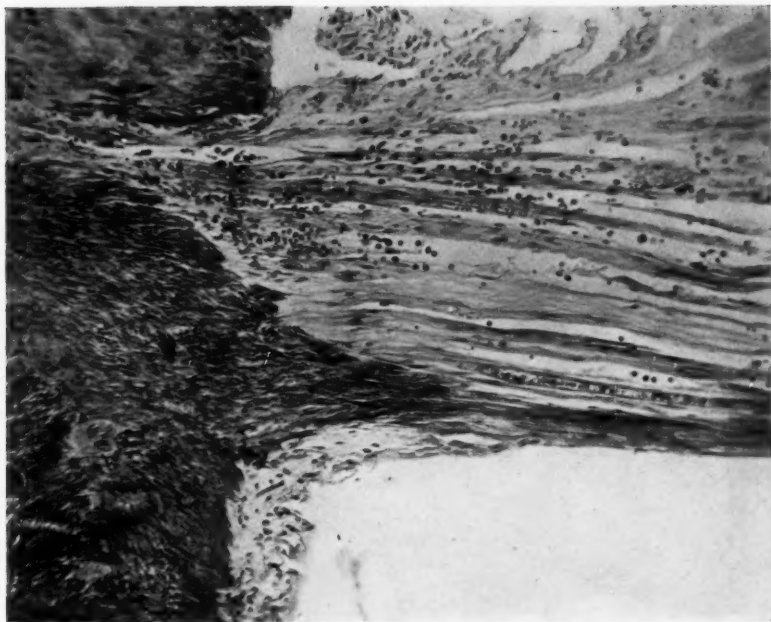


FIG. 5.—Adhesions after ten days ($\times 130$ diams.). Dense fibrous tissue.

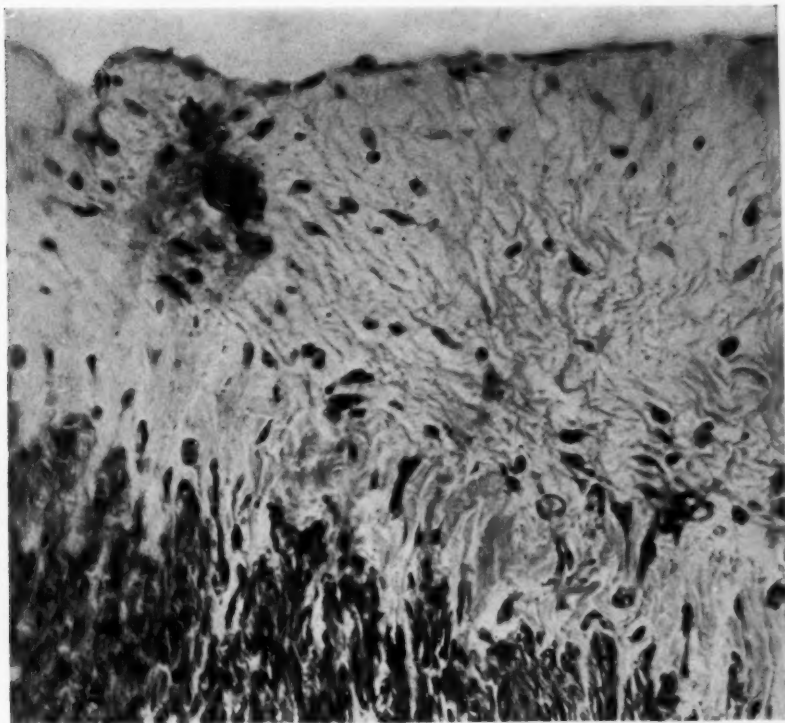


FIG. 6.—Adhesions after ten days ($\times 375$ diams.). Dense fibrous tissue springing from among the muscle bundles.

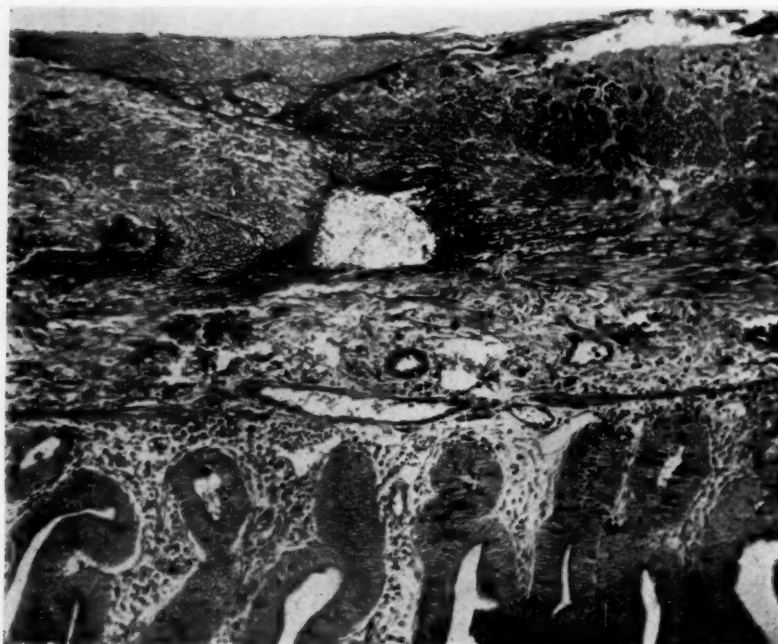


FIG. 7.—Scratched colon after two days (x 130 diams.). Adhesions prevented by citrate solution.
Wide reaction in the tissues and very little fibrin on the surface of the bowel.

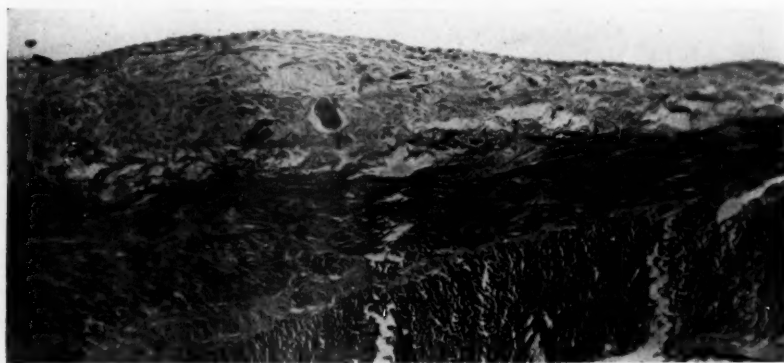


FIG. 8.—Scratched colon after eight days (x 130 diams.). Adhesions prevented by citrate solution.
Thickened fibrous subserosa covered with peritoneum.

PREVENTION OF PERITONEAL ADHESIONS

body where tissue is destroyed, modified somewhat by the conditions in the abdomen. First, following the injury to peritoneum, an inflammatory exudate is poured out. This exudate of serum and blood very quickly coagulates and is composed of fibrin with a few red and white blood-cells in its meshes. This fibrinous mass adheres to the structures adjacent to its source, and is the framework on which the fibrous adhesion is built. Very soon (in less than 48 hours) the connective tissue and endothelial cells at the base of the adhesion begin to proliferate. Fibroblasts and new blood-vessels appear reaching out into the exudate. This process of organization goes on rapidly until, at the end of a week, the adhesion is made up of fairly dense fibrous tissue, containing a moderate number of blood-vessels, with no inflammatory exudate. As time goes on, the blood-vessels become less numerous and the tissue denser. The endothelial covering of the peritoneum at the base of the adhesion disappears, and the fibres of the adhesion appear to reach in among the muscle-bundles of the muscular coat of the bowel, or of the abdominal wall, as the case may be.

Meanwhile the endothelial cells of the peritoneum have proliferated and covered the abdominal surface of the adhesion, being continuous with the covering of the bowel. The final appearance of the adhesion is simply that of a dense scar tissue band covered with peritoneum.

Prevention of Adhesions.—The technic followed in these experiments varied somewhat in detail during the course of the work, but the principal steps were the same. Laparotomy was performed; the colon scratched as described above; and the solution to prevent adhesions introduced just before closure of the wound. The details of the technic used during the latter part of the work were as follows: The hair was removed from a small area of the abdomen with depilatory (barium sulphate and starch, equal parts). The abdomen was scrubbed with benzine, Harrington's solution and alcohol. The abdomen was opened in the median line; the proximal two to three inches of the colon scratched with a sharp-pointed knife with many scratches (40-50), the scratches going down to the submucosa. A few scratches were made in the cecum. The peritoneum was closed with a button-hole stitch of silk, the last stitch being left loose to allow the introduction of a glass funnel. The solution being tested was poured through the funnel, care being taken to have the temperature of the solution as nearly as possible that of the body. The peritoneum was then quickly closed to prevent the escape of any solution, the skin closed with a button-hole stitch of linen, and the wound dressed with collodion.

Before undertaking the experiments with citrate solutions, one experiment was tried, to satisfy our own curiosity, using 15 c.c. of

sterilized liquid petrolatum. The abdomen was reopened in 7 days, disclosing a mass of thick, slimy adhesions. The oil had not been absorbed to any appreciable extent, and had rather increased the extent of the adhesions. This observation is borne out by the results of other experimenters.¹

Theory for the Use of Citrate Solutions to Prevent Adhesions.—The first step in the formation of adhesions, as we have seen, is the production of a mass of fibrin, the foundation for the fibrous tissue. If then we can arrest the process at the first step, *i.e.*, prevent the coagulation of the exudate with the resulting fibrinous mass, we can prevent adhesions.

Fibrin is formed by the action of thrombin on fibrinogen which ordinarily takes place in shed blood. There are two factors necessary for this action to take place:²

1. Calcium—in the absence of calcium, shed blood remains fluid.
2. Some undetermined substance in the nature of a kinase which activates the inactive prothrombin of the circulating blood to form the active thrombin.

It is well known that fibrin formation in shed blood can be delayed indefinitely by the addition of citrates or oxalates to hold the calcium. Why should not this principle be applied to the fibrin formation of early adhesions?

This, then, is the theory on which the work is based.

The next problem is that of keeping the solution in the abdomen long enough to take up the calcium in all the exudate which will be poured out after injury to the peritoneum. Isotonic or hypotonic solutions are absorbed very rapidly by the peritoneum, large amounts being taken up in a few hours.³ On the other hand, hypertonic solutions remain much longer; the amount may even be greater after a few hours than that originally introduced, because of the outpouring of fluid from the tissues to equalize osmotic pressure. In our experiments with hypertonic solutions in the abdomen we have found some of the fluid present after 48 hours.⁴ At this time the acute exudative reaction following peritoneal trauma seems to be well over. The solutions chosen

¹ Adams, Joseph E.: Peritoneal Adhesions—An Experimental Study. *The Lancet*, March 8, 1913.

² Howell, W. H.: Rôle of Antithrombin and Thromboplastin in Coagulation of the Blood. *Am. Jour. of Physiol.*, vol. xxix, p. 187.

³ Robinson, Byron: Observations upon the Absorption of Fluids by the Peritoneum. *ANNALS OF SURGERY*, vol. xxv, p. 332.

⁴ Pope, Saxton: Use of Citrate Solutions in the Prevention of Peritoneal Adhesions. *ANNALS OF SURGERY*, vol. lix, p. 101.

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for our experiments, therefore, were hypertonic solutions of sodium citrate and sodium chloride.

First, to make sure of the harmlessness of the solution, 5 c.c. of a solution of sodium citrate 2 per cent. and sodium chloride 3 per cent. was injected into the jugular vein of a rabbit. No ill effects whatever followed.

The experiments with the various solutions of citrate and chloride with their results are recorded in the following tables. Adhesions are not considered true, lasting adhesions until at least four days after operation, for earlier than that they are mostly fibrinous and many of them may be broken up by peristalsis, movements of the animal, etc., and may not appear later. A few abdomens were reopened earlier than four days in order to secure early specimens for histological examination, but these are not included in the tables. For convenience we have adopted the following method of designating the extent of adhesions:

+++ signifies the amount of adhesions resulting from scratching the colon when no preventive measures are taken.

++ signifies a definitely less extensive group of adhesions.

+ signifies a very slight adhesion between the bowel and the abdominal wound, without any between bowel and bowel. Such adhesions practically always were found where the wound was septic.

EXPERIMENTS AND TABULATED RESULTS

Group 1.—Using sodium citrate 2 per cent. and sodium chloride 3 per cent., about 12 c.c. Six operations; results as follows:

Adhesions	0 in 2 cases	
Adhesions	+	in 2 cases
Adhesions	++	in 1 case
Adhesions	+++	in 1 case

Complete success in $33\frac{1}{3}$ per cent.

Partial success in $83\frac{1}{3}$ per cent.

Group 2.—Using sodium citrate 2 per cent. and sodium chloride 8 per cent., about 12 c.c. Seven operations; results:

Adhesions	0 in 2 cases	
Adhesions	+	in 2 cases
Adhesions	++	in 2 cases
Adhesions	+++	in 1 case

Complete success in $28\frac{1}{2}$ per cent.

Partial success in $85\frac{1}{2}$ per cent.

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Group 3.—Using sodium citrate 1 per cent. and sodium chloride 2 per cent., about 12 c.c. Four operations; results:

Adhesions 0 in 1 case
Adhesions + in 1 case
Adhesions ++ in 1 case
Adhesions +++ in 1 case
Complete success in 25 per cent.
Partial success in 75 per cent.

Group 4.—Using sodium citrate 2 per cent. and sodium chloride 1 per cent., about 12 c.c. Four operations; results:

Adhesions 0 in 0 cases
Adhesions + in 2 cases
Adhesions ++ in 2 cases
Complete success in 0 per cent.
Partial success in 100 per cent.

Group 5.—Using sodium citrate 2 per cent. and sodium chloride 2 per cent., about 12 c.c. Two operations; results:

Adhesions 0 in 0 cases
Adhesions ++ in 1 case
Adhesions +++ in 1 case
Complete success in 0 per cent.
Partial success in 50 per cent.

Group 6.—Using sodium citrate 3 per cent. and sodium chloride 1 per cent., 20-25 c.c. Seventeen operations; results:

Adhesions 0 in 12 cases
Adhesions + in 3 cases
Adhesions +++ in 2 cases
Complete success in 70½ per cent.
Partial success in 88⅓ per cent.

Theoretically, the effect of oxalates should be the same as that of the citrates. Therefore, two experiments were performed using a solution of potassium oxalate 3 per cent. and sodium chloride 1 per cent. The first animal died about ten minutes after the operation from shock; and the second died during the second night presumably from the same cause.

The best solution, then, was found to be that used in Group 6, citrate 3 per cent. and chloride 1 per cent. Of the five cases which developed adhesions when treated with this solution, 4 had septic wounds, and we found that the presence of sepsis always caused adhesions. The other animal died of pneumonia in 3 days and had peculiar hemorrhagic septic adhesions.

It is fair to say, then, that in the absence of sepsis, and under good conditions, this solution always prevented the formation of adhesions.

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The amount of surgical shock caused by the solutions varied with their tonicity. This shock was measured in these rabbits by their rousing from ether when the solution was introduced, and by their recovery from ether. The solutions of very high tonicity, like the oxalate, caused most shock and even death in a few cases. It is well known that rabbits are more susceptible to any surgical procedure than almost any other animal. Hence things which cause profound surgical shock in rabbits may have no effect on cats or other animals. Our best solution, in some cases, caused slight rousing from ether, but the animals recovered quickly, in 10-15 minutes, and in no case were there any lasting effects.

Attempts to Prevent Adhesions from Reforming.—It is much easier to prevent adhesions than to cure them. The reason for this is probably largely found in the histology of adhesions. As we have said, the normal peritoneal coat of the bowel at the base of an adhesion is destroyed. Hence when the adhesion is removed a large area is left denuded of its peritoneum. Also in our work many abdominal wounds went septic after the second operation.

We performed 18 experiments of breaking up post-operative adhesions and introducing hypertonic citrate solutions of various strengths. Only one case was a complete success. Twenty-two per cent. of the cases were benefited by the treatment, but still had a few adhesions. The results here should be much better in human surgery, for there the element of sepsis would be practically wiped out.

The healing of the scratches in the colon where adhesions have been prevented, is much like the healing of a skin wound which is kept covered with a wet dressing. The reaction in the tissues extends far beyond the line of the scratch. The subserosa and the muscular layers of the colon are filled with an exudate of serum, fibrin, and blood-cells far beyond the scratch. There is very little fibrin on the surface of the bowel, though the scratch itself is filled with an exudate. This exudate, however, contains a much smaller proportion of fibrin and a larger proportion of cells than the usual inflammatory exudate. The healing goes on in the usual way with the organization of the exudate, fibrous tissue formation, proliferation of the peritoneal endothelium to cover the defect; and the result is a somewhat thickened fibrous subserosa.

The effect of the citrate solution on the healing of scratches in the colon, therefore, is a very definite, marked diminution in the amount of fibrinous exudate, produced as an immediate result of the trauma. The prevention of adhesions is due to this fact, there being too little fibrinous exudate allowed to coagulate on the surface of the colon to cause adjacent surfaces to stick together.

CONCLUSIONS

1. Hypertonic citrate solutions do, under certain conditions, prevent peritoneal adhesions after laparotomy. The best solution is sodium citrate 3 per cent. and sodium chloride 1 per cent.
2. In human surgery, the citrate solution should, theoretically, be used as it has been experimentally: *i.e.*, after clean laparotomies, a sufficient amount of solution should be introduced into the abdomen to bathe the whole peritoneum (500-600 c.c.). Smaller amounts would be of little value, for any fluid introduced into the abdomen soon becomes distributed over the whole cavity. Practically, the question of whether or not the citrate solution will cause surgical shock in humans, must be determined by actual tests in the operating room. If, as we anticipate, no shock is caused, the solution should be used as advised above.
3. When it is necessary to pack off intestines with gauze, if the pack is wet with citrate solution, much fewer adhesions should result.
4. Absolute asepsis is essential. Adhesions cannot be prevented in the presence of infection.
5. Gentleness in handling peritoneum is important, for the more injured peritoneum left after operation, the greater is the likelihood of adhesion formation.
6. Large areas denuded of peritoneum should be covered by plastic operations or omental grafts, for the larger the denuded areas left, the more difficult is the prevention of adhesions.
7. Iodine should be used in abdominal surgery with great care, or better, not used at all, for a very little of it allowed to touch the bowel causes masses of adhesions.
8. Dry gauze should not be allowed inside the abdomen.

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THE PREVENTION OF PERITONEAL ADHESIONS BY THE USE OF CITRATE SOLUTION*

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IN the past two years at the University Hospital, and in the private work of Dr. Wallace I. Terry, we have used a solution of citrate of soda 2 per cent. with sodium chloride 2 per cent. in some 400 abdominal sections. All sponges and gauze pads were moistened with this solution.

In about twenty cases, a considerable quantity of the solution was left in the abdominal cavity. This amount ranged from 4 ounces to a pint. Since this procedure causes pain and partially rouses the patient it has been found expedient to have the incision almost closed before introducing the liquid. The abdominal wounds do show more oozing during closure, but in no case has it seemed to lead to failure of union nor to post-operative bleeding.

There is no evidence to show that the liability to infection is increased, but, on the contrary, where peritonitis was present, a marked improvement seems to have occurred.

The character of cases in which a quantity of solution was left in the abdominal cavity included general post-operative adhesions, acute obstructions, pus tubes, colectomies, resections, and tuberculous peritonitis. Ten of the entire number of cases have come to reoperation and the state of the peritoneum could be inspected.

While it is very difficult to judge the evidence thus afforded, impartially, it is universally conceded by the surgical staff that there was a marked improvement in all but two instances. In such operations as appendectomies, where, upon reopening the abdomen, the omentum usually is found adherent to the old cicatrix, after citrate employment no such adhesions exist.

The two cases showing little or no benefit from the solution were those of a perforating duodenal ulcer following gastro-enterostomy and chronic plastic peritonitis with multiple intestinal ulcers.

The most striking improvement was evident in a case of long standing stasis with adhesions and one of tuberculous peritonitis. In no instance did we use this measure as a substitute for peritoneal grafts or

* Read before the County Medical Society, January, 1915.

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plications. It is not intended to take the place of plastic repair of the peritoneum.

It is conceded that judgment is difficult and experience fallacious, here as in other medical problems. But in the use of citrate solution we have a new hypothesis and convincing experimental evidence.

In the place of a mechanical conception of protection within the abdomen, and the use of such foreign substances as petrolatum and other tissue insults, we conceive inflammatory deposits to depend upon similar factors to those active in the production of thrombosis. We seek to limit fibrin deposits in the peritoneal cavity by an inhibition of the fibrin ferment.

It is not possible to abolish inflammatory repair nor do we attempt this. Our effort is to prevent excessive fibrin deposit and the subsequent conversion of this into adhesions.

By a comparative test of some twenty-four different substances, all of which have in the past been recommended as preventives of adhesions, we have shown by repeated experiments¹ on rabbits that citrate solutions are definitely superior to all hitherto suggested measures.

Petrolatum, camphorated oil, olive oil, butter, sugar solutions, ether, salt solutions, vitreous humor, paraffin oil, various membranes and powders all have been used. Some were found absolutely destructive and harmful—all are incompatible with animal tissue, and none compared in its preventive action with solutions of salt and sodium citrate.

Clinically, the evidence is more difficult to interpret, but the results in these 400 cases warrant us in recommending its use. It is not only a reasonable theory, one proved experimentally, but it is a safe surgical procedure.

Results of 100 Experiments on Rabbits.—After scarifying the colon and scrubbing the peritoneum with gauze—half an ounce of one of the following substances was poured in the abdominal cavity—the results after one week, are recorded as follows.

TABLE I

	Exudate	Adhesions
Control	+	++
Tr. iodine	++	++
Camphorated oil	+++	+++
Olive oil	++	++
Petrolatum	++	++
Butter	++	++
Sugar 50 per cent. solution	+	++

¹ The Use of Citrate Solutions in the Prevention of Peritoneal Adhesions. ANNALS OF SURGERY, January, 1914.

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	Exudate	Adhesions
Citrated sugar	+	+
Egg albumen	+	+
Citrated egg albumen	++	+
Milk	+	+
Peptonized milk	+	—
Ringer's solution	—	++
Salt solution, normal	—	+
Ether	+++	++
Vitreous humor	—	+
Paraffin oil	+	+
Oleum Telesphoros	++	+
Bloodclot	++	+
Ammonium oxalate 1 per cent. } Salt solution	—	+
Citrate of soda 1 per cent. } Salt solution	—	—
Sodium citrate 2 per cent. } Sodium chloride 4 per cent. } in water	—	— —
Citrate of soda solution 2 per cent. } Salt solution 3 per cent. }	—	— —

REMARKS ON THE SURGERY OF THE EUROPEAN WAR*

WITH A DESCRIPTION OF AN IRRIGATION SYSTEM FOR PERFORATING INFECTED WOUNDS

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ON the first of July, 1915, the University of Pennsylvania Unit, headed by Dr. J. William White and Dr. James P. Hutchinson, took over the University Unit of the American Ambulance in Paris from the representatives of the Harvard University.

The American Ambulance was started by the Americans in Paris, especially those connected with the American Hospital, which is situated in Neuilly just outside of the gates of Paris. This little hospital has about fifty beds and is very efficient in every respect. I believe the original idea was to construct a small temporary war hospital within its grounds. However, soon after the war began the French government turned over to the American Hospital the nearly completed school building, known as the Lycée Pasteur in Neuilly, to be used as a War Hospital, and this was where our work was done. At the time the war broke out, in August, 1914, this building was very nearly ready for occupancy. It is a structure which in America would cost from half a million to a million dollars and is built of brick with stone trimmings. There are four floors and a basement. The entire building is open to light, it being constructed in corridors with a front administration building and a central garden or court, so that all parts open within and without. The basement was used for dining halls and storage rooms. The first or ground floor has three large and seven small wards and the second and third floors each have about eighteen or twenty small wards of ten beds each. The dental department is on a wing of the second floor, the main operating room on a wing of the first floor, and the University Unit operating room on a wing of the fourth floor. The ambulance drivers and orderlies sleep on the fourth floor. The building, except for the fact that there are no elevators, is remarkably well adapted for the use of a hospital. The wards are very light, and there is plenty of air. The absence of an elevator, however, is a very great disadvantage, since one operating room is on the first floor and the other on the fourth, also that there are two X-ray plants, one adjacent to each operating room.

* Read before the Philadelphia Academy of Surgery, November 1, 1915.

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When I went on duty the services were divided as follows: Dr. Du-Bouchet was Surgeon-in-Chief and had a service of his own of approximately 160 beds; Dr. Blake had a service of 150 beds; Dr. Mignot of the French Army had a service of about 80 beds; and the University Unit had a service of 180 beds, which included the entire third floor with the exception of one ward. This was given over to the treatment of the eye, and was in charge of Dr. Hunter Scarlet.

The orderlies were of all types; some were paid, most were volunteers. Some of the finest types of men I ever met were doing that very necessary work. There were at least a dozen Oxford undergraduates working in that capacity, most of these being American Rhodes scholars, and as a rule these men did their work well. I, personally, never failed to have an orderly do whatever I asked him to, cheerfully and willingly at any time of the day or night. There were a great number of different nationalities represented among the workers, including doctors, orderlies, nurses and auxiliaries. My recollection is that they include French, American, English, Scotch, Irish, Canadians, Australians, Swiss, Russians, Belgians and Danish.

The question of infection is naturally a very important one, and I feel safe in saying that all the cases, or practically all, were infected at least in a slight degree. The slightly infected wounds were usually in those parts not covered by clothing and in which there was a slight laceration by a piece of shell or a clean puncture by a high velocity bullet. The infections were of all the usual types that we find at home with the addition of the gas bacillus. It seemed to us that the severity of the infection in many instances was increased when the patients gave a history of a great number of different dressings done in different places in the first forty-eight hours following injury. The length of time that the man had worn his clothing, both uniform and underwear, was another important factor in determining the severity of the infection. In many cases, injured in a part covered by clothing, pieces of coat, underwear, socks, etc., were recovered from the wounds for a long period of time following admission to the hospital.

In discussing the treatment of these varied types of wounds, I might say that hardly any two cases could be treated alike. Of course, the same general principles applied to all and sometimes the success or failure of a type of apparatus for one case would be of value in treating succeeding similar cases.

In deciding how we should treat a given case, it was necessary first to determine whether amputation would or would not save life. (Of course, all wounds were not of the extremities, but I am speaking of

them in that manner because a large proportion were, and because it was mostly in these cases where the question of judgment was of vital importance.) Our attitude was to avoid amputation when possible, not from the idea of the end-result to that particular part, but from the point of view as to whether the patient would throw off the infection and stand later amputation better.

After placing the injured part in that type of apparatus which appeared to be most comfortable, the question of the treatment by dressings came up. These were usually one of three classes: First, wet gauze dressings frequently changed; second, the steady drip of some solution; and third, irrigation.

The solutions most frequently used for wet gauze dressings were the sodium hypochlorite solution of Dr. Carrel, a normal salt solution, boric acid solution, alcohol, and sterile water. Except for the alcohol, these were always used very hot, very well wrung out, and very well covered. Our Service felt that the type of solution used in this manner was a very small determining factor as to the result. For irrigations the solutions used were again the hypochloride, salt, sterile water, and, in addition to these, sometimes weak iodine. Again, in this type of treatment we felt that the determining factor was not the chemical constituency of the solution so much as the mechanical action. Dripping of wounds was done mostly in those widely lacerated superficial wounds where there was very violent infection.

Continuous irrigation was used in some cases of through-and-through perforating wounds, also in some few punctured wounds, but these latter were done more frequently at the time of dressing once or twice a day. There were numerous types of permanent irrigations. Dr. Alexis Carrel recommended one that was apparently the most efficient. The description that was given me of this apparatus was that a tube was placed in a wound of entrance and sealed there with collodion, and a tube placed in a similar manner in the wound of exit. The solution was therefore forced into the wound and out of the wound and the external surface of the limb was kept dry. The disadvantage of this was that it was not applicable in those cases in which the wound of exit was accompanied with terrible lacerations of the skin and soft parts. There was another type of irrigation in which a fenestrated tube was carried through and through the wound which connected above with the irrigating can and below with a waste bucket. Again the disadvantage of this was that the irrigation ended by being mostly of the tube itself and not of the wound. There were many other types. My colleague, Dr. Keating, evolved a very ingenious scheme



FIG. 1.—First case in which the described irrigation was used; multiple through-and-through wounds of the elbow. The result was satisfactory.

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with which he could irrigate from one main irrigating can multiple wounds of the arm or leg.

There were some cases of through and through wounds in which apparently hot wet dressings did not clear up the infection and some type of continuous irrigation was essential. After seeing some of these irrigations it occurred to me that if an old fundamental principle of hydraulics were used, we could procure an actual forced irrigation of the wound under pressure. This principle which I made use of was that water always flows the easiest way and that the easiest way could not possibly be through a wound unless it was forced through by back pressure, and therefore I worked out the following simple apparatus.

A soft rubber tube of the size necessary for a given wound was used. In the centre of this tube there was a single window cut in the shape of a gutter. This was placed in the wound, usually with the patient under anæsthesia. An irrigating can with a shut-off valve was connected with a glass T-tube. Soft rubber tubes came off of either end of the T, both of these having a shut-off valve either within them or a metal clamp. These were again connected with the tube within the wound at either end, and at the most dependent portion another T-tube was placed to which was attached another rubber tube with a shut-off valve which emptied into a bucket. In this way the water could be carried from the irrigating jar to the T-tube (Fig. 1), and by opening the valve on one side and closing it on the other the flow of the water was directed through the tube in the wound in whichever direction desired. With the valve on the dependent T-tube opened, the water flowed through the tube in the wound directly into the waste bucket, which showed us that the wound itself would not be irrigated in that manner, but when that lowest valve was closed, giving a back pressure, there was only one possible place that the water could escape, namely, through the window in the tube within the wound. In this manner the wound itself was irrigated around the tube and the pus was washed out mechanically. A slight change in the position of the window would determine which end of the wound would be flushed. In this manner we were able to keep up free drainage continuously. The solution coming from the wound was directed into the waste bucket, by rubber sheeting, and thus the bed was protected. This was tried on a number of cases with reasonably satisfactory results. *No irrigation of any type seemed to be of any value unless there was proper and sufficient drainage.*

There has been diversity of opinion in regard to the treatment of the gas bacillus infection. I believe it is generally agreed that where

gangrene resulting from this infection has set in, immediate amputation is indicated. There are some men who think that amputation is indicated whenever the diagnosis "gas infection" has been made, even when there is no evidence of gangrene. The feeling of our service was that cures of gas bacillus infection could be brought about without amputation if proper and sufficient drainage were instituted. By this I mean drainage not only of the skin and superficial fascia, but wide-open drainage of the muscles around the seat of infection. It was our policy to open the infected areas freely in many places and to insert through-and-through drainage tubes.

The following case that I will try to give from memory is typical of gas bacillus cases that are admitted to the American Ambulance.

This man was admitted a few days after he was wounded. He had had both legs amputated below the knee at the Base Hospital. The left leg was a straight amputation without flaps, and not closed. The right leg had been amputated with apparently some post-operative hemorrhage which had been controlled by packing, and a few sutures had brought the flaps together. When this man was dressed and the packing was removed there was no difficulty in making the diagnosis of "gas infection," as the gas bubbled out in abundance. The man was immediately taken to the operating room where all the sutures were removed and the stump was laid wide open. The question of further amputation above the knee was brought up and, with the exception of our chief, Dr. Hutchinson, practically every man present was in favor of further amputation. Dr. Hutchinson decided, however, that he would give the stump very free drainage and wait. The patient was returned to the ward, where the stump was put in a sling, was extended outside of the bed and a continuous drip of a salt solution was commenced. Twice daily the stump was irrigated with peroxide of hydrogen, which was washed off with a weak solution of iodine. At the time this treatment was instituted there was practically not a particle of live tissue visible. The bone was protruding for possibly two inches, all the muscles were gray and absolutely necrotic. I had this man in my ward for two months. When I left, the left stump was entirely healed and the right stump, which at the beginning of the treatment had been at least eight inches in diameter, was healed with the exception of about three-quarters of an inch, and there was a very little bit of bone still showing, but not protruding.

Practically all amputations that came to us from the front were no-flap amputations, and these were all treated in the same manner, namely, an extension put upon the flaps.

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The wounded that came to the American Ambulance during our period of service and for some time preceding that were all French or at least of the French Army. There were some Moroccans and Algerians, and some of the French negroes. The attitude of these men was nearly without exception that which made it a pleasure for anyone to work with them. They were always game, courteous, happy when not in actual pain, and full of gratitude for what little we were able to do for them. One case will always stand out in my mind as typical of the French people in this time when their very life is at stake. This case was a violent infection with fracture at about the middle third of the femur. He was turned over to us by the Harvard Unit, and I was warned by Dr. Collier of that Unit that he was in a serious condition. He was in a plaster cast with the usual reinforced window over his point of infection. About four days after we went on duty, in the night he had a hemorrhage. When I arrived in the Ward he was bleeding rather freely, and, of course, owing to the cast we were unable to use a tourniquet and I did not feel that there was time to remove the cast. With the aid of two candles (no electric lights were allowed after nine o'clock at night on account of the danger of Zeppelin raids) I packed this man's wound of entrance and exit under ethyl chloride general anæsthesia. When the hemorrhage was controlled his first words when he came out of anæsthesia were, "*Merci, Monsieur le Docteur.*" Gentlemen, that typifies the French soldier and his innate courtesy, which supersedes everything else. Another example—during the month of August I was slightly ill for a couple of days, which I spent in the American Hospital. The first day I arrived there I received a large basket of flowers, with a letter written in French by one of my fifty wounded men, and signed by every other one. I hardly believe that any set of ward patients in a home hospital would show that kind of consideration.

There was one man who suffered tortures every time I had to dress him for several weeks. I have seen him stuff a red bandana handkerchief in his mouth so that his groans would not disturb me. I have told him after a dressing that I was very sorry to have to hurt him, and his reply was always the same, "What would you? It is necessary." This same man when he was evacuated later to a less active hospital frequently came back to see us. The last time I saw him he told me that the surgeons in his new hospital wanted to open his arm and drain it. I asked him what he did and he replied that he would not let them do it. Then I said, "But supposing we wanted to do it?" His immediate reply was that that would be all right, and that was the attitude of the French soldier to the American doctors.

EDMUND B. PIPER

In closing there is one point that struck me most forcibly, namely, *War Surgery is distinctly Ward Surgery*, and the results that are attained are much more dependent upon the treatment in the wards, than upon the operations that may be done. Of course, many operations are needed, but that is the smallest factor in determining the end-results. Any man going to serve in a War Hospital with an idea that he will procure a large operative experience I believe will be sadly disappointed, but it seemed to us that the treatment of the cases in the wards was far more interesting and valuable than any operative experience that might be acquired, and no member of our Unit will ever regret the trip.

FRACTURES OF THE NECK OF THE SCAPULA*

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AND

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FRACTURES of the neck of the scapula with or without involvement of the glenoid fossa, while not common, have been found to be of more frequent occurrence since the advent of the X-ray.

Nearly all the clinical features of fractures of this region are based upon the description by Sir Astley Cooper of three personal cases, two of which at autopsy proved to be fractures of the surgical neck of the humerus. In brief, the symptoms ordinarily given are, flattening of the shoulder, the prominence of the acromion, the easy reduction of the downward displacement by raising the elbow and the immediate return of that displacement when this support is removed, and the occurrence of crepitus during the above manipulations.

With the appearance of the first two of the above symptoms we can heartily concur, although fracture of the surgical neck of the scapula may occur without any distinguishable deformity (see Case I).

In all of our cases in which there was not some concurrent injury to other structures, such as deltoid paralysis (Case VI) and the complicated lines of fracture in Case VII, there was no displacement which could in any way be affected by raising the arm, or by traction upon it. In our cases, likewise, passive movements of the arm described by Grüne as practically free and painless were distinctly restricted to very slight movements, and all were accompanied by pain referred to the infraclavicular fossa.

We must also disagree with Grüne in his statement that fracture of the neck of the scapula is one of the most common forms of scapular fractures and agree with the other writers that this is one of the less common types of fractures of the scapula.

The facts contained in this paper are based upon eight cases of fracture involving the neck of the scapula, and a series of experiments on the cadaver done chiefly to clarify our knowledge of the clinical types as we saw them.

* Read before the New York Surgical Society, December 8, 1915.

The case reports follow:

CASE I.—Thomas M., aged forty-four, was admitted to the First Surgical (Cornell) Division of the New York Hospital on December 12, 1914, with a history of having fallen against a trap-door four days previously. The injury was evidently merely annoying, as the patient did not seek treatment until the following day, and then because of the inability to use his left arm. He was treated for a sprained shoulder.

On his admittance to the hospital he had complete disability of the left shoulder. There was the very slightest difference in the two deltoid regions, perhaps only perceptible because of the prominence of the acromion process on the left side which made the contour seem slightly less rounded on that side. The left coracoid process was not so distinct as the right, and pressure over it caused pain in the infraclavicular fossa. There was pain in this region also upon pressure inward against the head of the humerus. Passive motions were less restricted than in the other cases in our series, but were distinctly limited, and the pain which occurred was referred to the infraclavicular fossa and to the summit of the axilla.

There was no ecchymosis, no change in the relationship of the head of the humerus and the acromion, and there was no change in the measurements from acromion to external epicondyle.

An attempt was made in this instance to measure the change in position of the two coracoids, measuring from the median line, and a difference of 0.25 cm. was found, that on the left side being that much nearer the median line. The measurements did not give any clearer impression than that given by the fulness in the infraclavicular fossa.

The X-ray showed a fracture through the surgical neck of the scapula with very little displacement. The treatment was similar to that in Case II. The result was a perfect restoration of function at the end of sixteen weeks with no evident disability or deformity (Figs. 1 and 2).

CASE II.—Joseph W., aged twenty-four, policeman, was admitted to the First Surgical (Cornell) Division of the New York Hospital on August 26, 1913, with a history of having been thrown and trampled upon while attempting to stop a runaway horse. The patient believes that he struck the left shoulder when he fell.

Examination.—There was complete inability to move the left shoulder-joint because of pain. There was a slight but definite flattening of the left deltoid region below the acromion as compared to the opposite shoulder, and the left infraclavicular fossa was smaller and less evident, especially on its outer aspect, than



FIG. 1.—Case I. Note the absence of any appreciable deformity; left shoulder.



FIG. 2.—X-ray of Case I. Note line of fracture through the surgical neck with very little displacement.



FIG. 3.—Case II. Note the prominence of the acromion and slight flattening of the left deltoid region.



FIG. 4.—X-ray of Case II. Shows the increased displacement. One year after injury shows the bony union better than earlier pictures.



FIG. 5.—X-ray of Case III. Note greater displacement than in above cases with fracture of the body of the scapula.

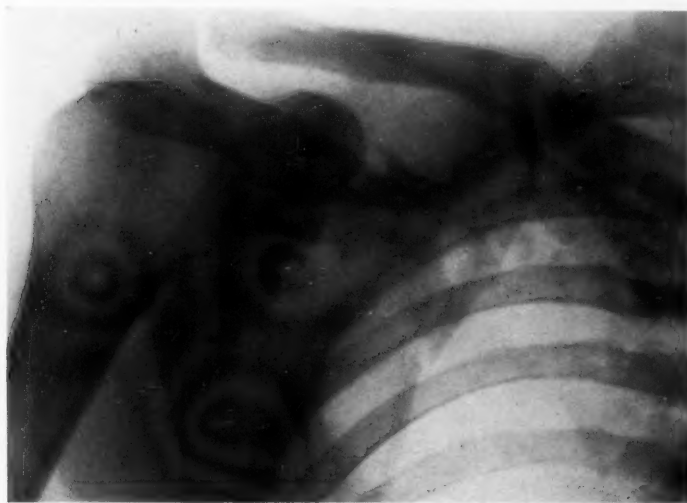


FIG. 6.—X-ray of Case IV. Note displacement and lines of fracture through the body and spine of scapula.



FIG. 7.—X-ray of Case VIII. Note the variation of the line of fracture through the surgical neck and compare with Case VII (Fig. 10).

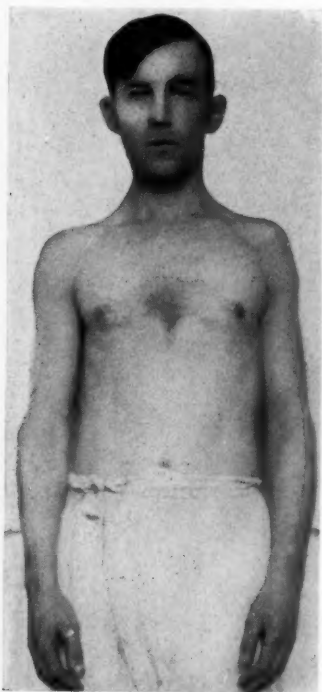


FIG. 8.—Case VI. Note deformity at left shoulder.

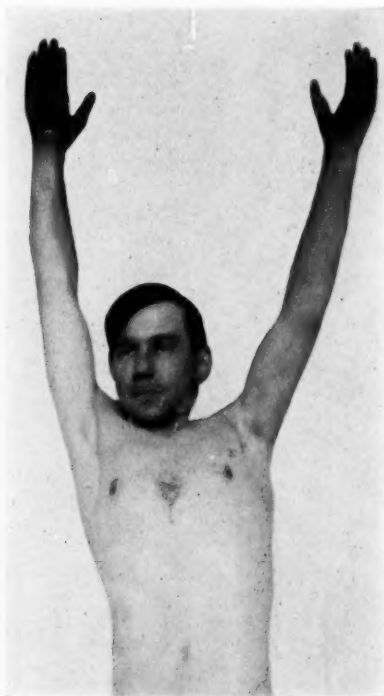
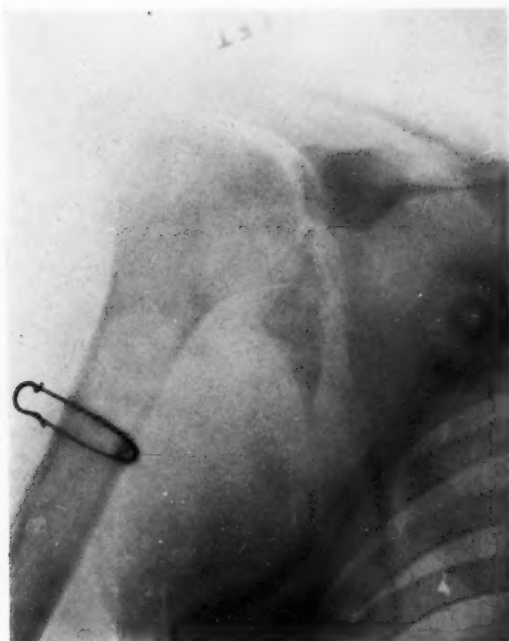


FIG. 8a.—Case VI. Function six months after injury.



FIGS. 9 and 9a.—X-rays of Case VI. Show degrees of displacement and bony repair.



FIG. 10.—X-ray of Case VII. Note the complicated lines of fracture, especially that from the notch to the glenoid fossa.

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the right. On palpation the head of the humerus rotated with the shaft and was in normal relationship with the other bony landmarks of the shoulder. As compared to the right side the acromion process seemed more prominent, and the bulge of the humeral head seemed to extend farther under it. There was no ecchymosis.

There was diffuse tenderness over the coracoid process and from there down through the apex of the axilla, increased by all passive movements of the arm, but especially by movements in the external rotation. Extension of the forearm against resistance gave very little pain, while flexion of the forearm against resistance gave pain in the infraclavicular fossa. Traction downward and pressure upward upon the elbow had no effect upon the position of the humeral head in its relationship to the acromion. Movement of the shoulder gave an indefinite crepitus best felt in the infraclavicular fossa and in the apex of the axilla. Elevation and depression of the scapula (whole shoulder girdle movements) against resistance caused no definite pain.

The X-ray showed a line of fracture through the neck of the scapula which ran from the suprascapular notch to the axillary border of the scapula about a half inch from the edge of the glenoid fossa. There were radiating lines of fracture in the body adjacent to fracture in the neck.

Reference to the description of the treatment as given by writers upon injuries of this nature stated that the deformity could be corrected by correcting the constant tendency to downward displacement by elevating the arm (Stimson, *Fractures and Dislocations*, 1912, p. 230).

This was tried and found to be a failure, inasmuch as no pressure upward nor traction downward upon the humerus had any effect whatsoever upon the position of the head of the humerus or the fragment involved in the fracture. (This latter was, of course, only determinable by the X-ray.)

Traction in the elevated and abducted position (Pringle, Grüne, Bardenheuer) likewise caused no change in the condition as demonstrable by change in the deformity or by the X-ray examination. In short, no manipulation or traction had any effect upon the lesion in question, and all of the above were abandoned for a Velpeau bandage.

Massage and baking were begun in the third week and passive motions one week later. At the end of eighteen weeks function was practically identical in both arms. Bony union occurred, as determined by the X-ray at the same time.

CASE III.—James M., aged forty-six, was admitted to the

First Surgical (Cornell) Division of the New York Hospital, January 6, 1914, with a history of having fallen twenty feet on his left side with his left arm against his side. This was followed by pain in the shoulder, and complete inability to use the arm.

Examination showed, among other contusions, one over the posterolateral aspect of the left shoulder just below the acromion. There was no ecchymosis except that directly above the contusion.

Deformity.—The bulge of the humeral head is less prominent than that on the opposite side, with slight flattening of the left deltoid region just below the acromion, the edge of which seems more prominent than that on the right side. The left infraclavicular fossa is slightly fuller than the right.

Disability.—Complete: Active motion is restricted to practically no movement of the arm. The head of the humerus rotates with the shaft but seems slightly further below the acromion than that of the other side. The coracoid process could not be felt.

Pain was elicited by direct digital pressure in the infraclavicular fossa (coracoid region), by pressure high up in the axilla, along the spine of the scapula, and in an irregular line over the body of the scapula below the spine. Pain was also elicited by pressure inward against the left shoulder (*i.e.*, crowding the shoulder together), the pain being localized in the infraclavicular region and over the left lateral thoracic wall. (The patient had fractures of the second, third, fourth, and fifth ribs.)

All attempts at passive motions of the arm caused pain in the infraclavicular region and high up in the axilla. Traction in all directions and pressure upward caused no change in the position of the head of the humerus in its relation to the acromion process.

Measurements.—From the posterior tip of the acromion to the external condyle showed the following: Left shoulder, 30.5 cm.; right shoulder, 31.0 cm.; *i.e.*, a shortening of 0.5 cm. on the affected side. A Velpeau bandage was applied and the treatment was similar to that of Case II. At the end of six months there was no detectable disturbance in function except the merest restriction in internal rotation of the shoulder. At this period there was likewise only the very slightest difference in the outline of the shoulder. One could hardly detect it.

Measurements.—From the coracoid to the mid-sternal notch gave the following measurements: Left side, 16.0 cm.; right side, 16.25 cm.; *i.e.*, the left coracoid was pushed 0.25 cm. nearer the median line.

The X-ray showed a fracture of the surgical neck of the scapula with a fracture through the body below the spine of the scapula and the fractures of the ribs above mentioned. The

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glenoid fragment was displaced more than in the two preceding cases, and the fracture lines overlapped distinctly.

CASE IV.—Alexander D., aged thirty, plasterer, was admitted to the House of Relief, New York Hospital, Service of Dr. F. W. Murray, on July 5, 1914, with the history of having been caught between an elevator and a projecting beam.

The record at the House of Relief states that the left shoulder was swollen and all active and passive movements were restricted by pain, especially marked over the coracoid region where crepitus was felt. There was no note of ecchymosis, pain, or digital pressure, etc.

He came under observation at the Fracture Clinic of the First Surgical Division of the New York Hospital on July 23, 1914, with the arm in a Velpeau bandage.

Examination (eighteen days after injury).—At that time the left shoulder seemed slightly less rounded than the right. The acromion process was distinctly more prominent on the left side. The left infraclavicular fossa was less distinct than its opposite. There was pain on pressure over the coracoid region, and pain referred to the infraclavicular fossa on pressing inward over the head of the left humerus.

All movements, active and passive, were restricted and painful, the maximum pain being referred to the infraclavicular fossa and the summit of the axilla.

There was no evidence of ecchymosis at this time except some over the deltoid region just beneath the spine. There was also no disturbance between the relationship of the head of the humerus and the acromion process.

Measurements from the tip of the acromion to the tip of the external epicondyle showed no difference on the two sides.

The X-ray showed a line of fracture through the surgical neck of the scapula. There was also a line of fracture in the body which ran from the above line of fracture transversely to the vertebral border of the scapula, and an additional line of fracture from the last-mentioned fracture upward through the spine of the scapula to the superior border of the scapula.

The treatment was similar to that described for Cases II and III, with a complete restoration of function in eighteen weeks.

Result.—No distinguishable deformity or disability at the end of six months.

CASE V.—John H., aged thirty-one, admitted to the accident ward of the New York Hospital, November 11, 1908, with a history of having fallen on the left shoulder. There was inability to move the left shoulder and pain in the whole shoulder-joint.

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Pressure high up in the axilla along the axillary border of the scapula gave a point of tenderness which was increased by extension of the forearm against resistance. The bony landmarks were in normal relationship.

X-ray showed a fracture of the lower third of the glenoid with displacement of the fragment downward. The arm was put up in a Velpeau bandage. The patient did not return for further treatment.

CASE VI.—John S., aged twenty-three, packer, was admitted to the Out-Patient Department of the House of Relief of the New York Hospital, on August 25, 1913, with a history of having fallen from a wagon forty-eight hours before coming to the hospital.

Examination was negative except for the left shoulder, which was the seat of a fairly extensive ecchymosis. There was marked flattening of the shoulder with prominence of the acromion as compared to the opposite shoulder. Disability was marked and painful, and active movements were limited in all directions. Passive movements were free but quite painful, and extension of the forearm against resistance caused pain referred to the axilla and the shoulder-joint. Flexion of the forearm against resistance caused no localized pain. The whole region of the shoulder-joint was painful, and a sense of an indefinite crepitus was obtained in the axilla upon to-and-fro movements of the shoulder.

A Velpeau bandage was applied for three weeks. At this time the deformity was noticeably increased and the head of the bone seemed to have fallen farther away from the acromion process. Movements in abduction seemed to show contraction in the deltoid muscle (evidently an erroneous observation). Two weeks later, *i.e.*, five weeks after the accident, there was evident atrophy of the deltoid with a definite electrical reaction or degeneration only obtainable by the use of a very strong galvanic current. Massage and galvanism were used at irregular intervals, due to the patient's failure to attend the clinic (New York Hospital Out-Patient Department) up to December 19, 1913.

On December 19, 1913, he was admitted to the New York Hospital and a thorough electrical examination showed a beginning return of motor function in the circumflex nerve, although a much stronger current was necessary to cause the contraction of the deltoid on the left side.

One year after the injury function was practically perfect on both sides, although there was still some atrophy of the left deltoid. The head of the bone on the left side seemed at about the same level in its relationship to the acromion as that of the right side.

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The interesting feature of the case was the inability to correct the deformity by lifting up the arm as described in practically every description we have seen in lesions of a similar character. Later, when the deltoid paralysis became more pronounced and the dropping of the humeral head more evident, pressure on the elbow in raising the arm overcame the downward displacement of the head.

With the return of deltoid function the deformity practically disappeared, although no change in the line of fracture was obtained by the treatment, *i.e.*, the bone healed in identically the same position it occupied after the injury.

X-rays were taken at frequent intervals. The first showed a line of fracture (Figs. 9 and 9a) which began just above the centre of the glenoid fossa and extended down through the neck to the axillary border of the scapula. The separation of the fractured fragment is well shown in the X-ray. Sixteen weeks after the injury the fragment was united by bone along the line of fracture, except at its lower third. One year after the injury, bony union was complete throughout.

It will be seen from the location of the line of fracture in the X-ray picture that the circumflex nerve was evidently injured by the displaced fractured fragment. At no time was it possible by high axillary palpation to determine any thickening of the scapula at the line of fracture along the displacement, although the amount of bone required for the repair process seemed likely to give such thickening.

CASE VII.—Miss Theresa J. N., aged fifty, was admitted to the Private Pavilion of the New York Hospital, on March 15, 1915, with a history of having fallen or jumped out of a five-story window.

Among a number of other injuries was that to the left shoulder. The left shoulder was markedly altered in appearance, the deltoid contour being less rounded than its fellow, and the shoulder lower. There was marked prominence of the outer end of the clavicle, and the acromion on that side seemed more prominent and also tilted slightly forward.

There was a contusion over the scapular region behind with fairly extensive ecchymosis in this region and also over the deltoid region and along the inner aspect of the chest wall in the post-axillary line.

It was difficult to determine painful areas, as the whole shoulder was painful. It could be readily determined that there was a dislocation of the outer end of the clavicle, a line of fracture in the spine of the scapula, and pressure over the coracoid region gave a definite bony crepitus.

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Measurements from the acromion to the external epicondyle showed no change in the position of these bony points as compared to the opposite side, although the shoulder was distinctly lower than its fellow. Raising the arm corrected this downward displacement and the dislocation of the clavicle.

The arm was dressed in the adhesive plaster dressing of Stimson and a starch Velpeau.

X-ray (Fig. 10) shows a line of fracture from the suprascapular notch through the base of the coracoid to a little below the middle of the glenoid fossa. In addition it also shows a fracture of the base of the acromion process and a dislocation of the outer end of the clavicle.

The patient last came under observation in June, 1915, three months after the injury, and at that time there was fairly marked disability, motion being restricted in all directions. Passive movements could be executed to a little beyond a half of the normal.

(Due to a definite mental condition and the difficulties resulting from it, all our methods had to be modified at different times throughout the treatment.)

CASE VIII.—Wm. Mc., aged thirty, a patient of Dr. Charles Farr, to whom we are indebted for the history and pictures of the case, fell from a wagon, injuring the right shoulder. It was put in plaster for five weeks. At the end of three months there was no appreciable deformity and there was a fair functional result.

The X-ray shows a type of fracture which is intermediate in its grouping between Cases I, II, III, IV and VII, and is an interesting variation from the ordinary type of scapular fracture of the surgical neck. The line of fracture runs through the surgical neck, but in addition there is a separate line of fracture which has split off a fairly large fragment of the glenoid fossa and displaced it into the axilla. This case, we believe, should be included among the fractures of the surgical neck of the scapula and should be described as a variation of that type of injury.

ANALYSIS OF THE CASES

The fractures of the neck of the scapula fall into the following groups:

I. *Fractures of the Surgical Neck* (Cases I, II, III, IV and VIII).—In these the line of fracture begins in the suprascapular notch and runs to the axillary border of the scapula at or below the infraglenoid tubercle. This is the most frequent type in our series. Tanton states that the line of fracture may be complete or incomplete. Ours were all complete. There may be little or no displacement. Grüne

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cites ten cases of this type, nine of which showed no displacement. All of our cases showed some displacement of the fractured fragment inward, as shown by the X-ray. This was the least in Case I, and most marked in Case IV. Case I showed no other line of fracture than that through the surgical neck. Case II showed some irregular lines of fracture in the body of the scapula adjacent to the neck, while Cases III and IV showed lines of fracture extending clear across the body of the scapula and involving the spine of the scapula.

Cause: In all of the cases the injury resulted from a blow received upon the shoulder. In Case I, the only one in which it was definitely determinable, the impact was received against the point of the shoulder just a little behind the centre. In this case the impact was relatively slight, the patient falling only a portion of his length. In the other three cases all were types of a severe injury, Case II being due to the impact of a running horse throwing the man against his shoulder; Case III, a fall of twenty feet; and Case IV, a crush between a moving elevator and a projecting beam. In these three cases there was also a coincident fracture of the body of the scapula, and that coincident fracture was most extensive in the cases (III and IV) in which the violence was the most extreme.

Symptoms: 1. Deformity: In none of these cases was there any deformity which might be described as characteristic. All showed a little flattening of the deltoid, some prominence of the acromion, and a change in size of the infraclavicular fossa, *i.e.*, that fossa was smaller and more filled in than its opposite.

2. Ecchymosis was absent except in one case which had a contusion over the deltoid region. Later, extravasation of blood appeared as a yellow stain high up in the axilla, and in the infraclavicular fossa in all the cases.

3. Disability was complete in all the cases.

4. Pain was present on direct digital pressure over the coracoid region in all the cases. There was also pain on pressure high up in the axilla in two of the cases. Cases III and IV (those with additional lines of fracture through the body) gave pain on direct digital pressure along the line of these fractures.

On crowding the head of the bone inward, pain was elicited in the infraclavicular fossa and high up in the axilla. Pressure upward on the elbow gave no pain if care was taken to avoid any movement of the arm during the manipulations. In Cases III and IV, pressure on the upper and lower angles of the scapula gave pain along the line of the digital pressure pain.

Extension of the forearm against resistance gave very little distress and it was diffuse rather than localized. Flexion of the forearm against resistance gave pain of a variable degree localized to the infraclavicular fossa.

5. There was no change in the relationship of the head of the humerus to the acromion, the head rotated with the shaft, and pressure upward and traction in all directions caused no change from the normal. In two of the cases a note is made that the head seems further beneath the acromion.

6. Passive motions were restricted to almost no movement before pain began to limit them.

Diagnosis: The points in diagnosis which would suggest a fracture of this type are, (1) a fall upon the shoulder followed by a disability at that joint with the pain localization described under symptoms (Paragraph 4), and the absence of a change in the head of the bone in its relationship to the acromion, its rotation with the shaft in this position, and the inability to influence that position by manipulative efforts upon the arm.

While all of the above facts would strongly suggest a fracture in the surgical neck of the scapula, its actual presence must be confirmed by a suitable X-ray picture before the diagnosis can be said to be completely established. Naturally enough, an autopsy in fatal cases would give the needed confirmation if an X-ray were absent.

In all four of the above cases the diagnosis was made clinically, Cases I, II and IV, coming as they did after Case II, were not difficult, but we were not positive of our diagnosis until we had seen the X-ray.

II. *Fractures of the Lower Half of the Neck of the Scapula.*—In this type the line of fracture begins at or below the middle of the glenoid fossa, extending downward obliquely through the neck to the axillary border of the scapula. Our series contains two cases of this type which are similar to the case described by Spence.

Cause: The cause given in both cases was a fall upon the shoulder. Both patients were intoxicated when the injury was received, and no definite statement of the nature of the fall could be obtained. In neither case was there any local contusion to explain the point of impact. The position and the direction of the line of fracture suggest strongly that the fracturing force was received upon the anterior point of the shoulder and transmitted through the head of the bone downward. (Attempts to produce this lesion by this mechanism in the cadaver failed, and fracture of the head occurred.)

Symptoms: There was no deformity in one case except the swelling

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of the shoulder girdle. In the other there was marked flattening of the shoulder due to a coincident circumflex nerve injury.

Ecchymosis was present in one case and absent in the other. In the case in which it was present the whole shoulder region and the axilla were involved in the extravasation.

Disability was complete in both cases.

Pressure against the shoulder, *i.e.*, crowding the shoulders together, gave pain localized to the shoulder region, and especially high up in the axilla.

Movements of the arm against resistance: Pain localized high up in the axilla was present in extension of the forearm against resistance, and absent in flexion against resistance.

Crepitus: An indefinite crepitus was obtained by to-and-fro movements of the arm at the shoulder. No crepitus similar to that described by Ashhurst in his case could be obtained.

There was no change in the bony relationships except in one case in which the head of the bone was perceptibly lower in its relationship to the acromion (deltoid paralysis). This increased perceptibly as the paralysis became more pronounced.

Passive movements were restricted to about one-third the normal range of motion, and were painful.

Traction downward and pressure upward upon the arm did not affect one case. In the other these movements, due to the deltoid paralysis, did alter the position of the head, in that it would come farther away from the acromion in downward traction, and could be brought closer to that process when the arm was lifted upward, a phenomenon which was not due to the bone lesion, but was due to the circumflex nerve injury.

In one case there was a coincident deltoid paralysis which reached its maximum five weeks after the injury and which, we believe, was responsible for such deformity as occurred in this case. Return of nerve function began four months after the injury and eventually became complete, although there was still some atrophy of the deltoid on the left side with its coincident degree of weakness in the muscle.

Diagnosis: The same remarks apply in this type as are given under Type I.

III. *Fractures of the Neck of the Scapula Beginning at the Notch and Extending Downward Through the Base of the Coracoid Process to the Glenoid Fossa.*—This type is represented in the literature by Braun's case which Stimson has included under the fractures of the coracoid process. It is represented in our series by Case VII, and we

believe it should be included in the fractures of the neck of the scapula. One can readily see a reason for this by comparing Case VIII, which is similar to this type except that there is an additional line of fracture to that given for this group, which extends through the surgical neck and makes a separate fragment of that portion of the glenoid and surgical neck which remains unbroken in this type.

The same remarks apply here in determining the diagnosis as were given under that heading under fractures of the surgical neck.

Treatment: The only treatment we found to be essential was rest and this was best obtained by a Velpeau bandage. All the other forms of treatment had no effect upon the bone displacement. The arm along the head position described by Grüne and pictured by him and Bardenheuer, and the abducted position described by Pringle were used in Case II. The only possible benefit that might accrue from this position is the more rapid restoration of abduction. This is in turn counterbalanced by the necessity for keeping the patient in bed, a form of procedure we did not find essential to a perfect functional result.

The Velpeau bandage should be worn from three to four weeks, massage and baking begun on the third week, and passive and active motions with the removal of the bandage. The too early use of motion gained nothing, in our experience, and we believe that such motion as is permitted should be restricted to movements which are not painful.

Result: Bony union occurred in Cases I, II, III, IV and VI. The character of the union is unknown in Cases V, VII and VIII. Cases VII and VIII are reported as satisfactory but there is no X-ray evidence.

Function was practically perfect in Cases I, II, III, IV and VI. Case V disappeared. In Case VIII it is stated as fair. In Case VII function is reported as distinctly limited and movements of the arm are accompanied by pain.

IV. *Fractures of the Anatomical Neck.*—We could find no authentic case of this type. Plageman reports three cases of fractures of the anatomical neck. He does not show any of the X-ray pictures from which he states the diagnosis was made, and the diagnosis given in his text lacks confirmation in the experience of any other writer upon this region. We are therefore inclined to doubt the existence of such a fracture.

V. *Stellate Fractures of the Glenoid Fossa of the Scapula.*—We have seen none of this type. The literature (*vide infra*) contains the cases at present reported.

VI. *Fractures of the rim of the glenoid* with or without fissures run-

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ning into the neck are frequent in dislocation of the shoulder. They are, however, complicating injuries in dislocations and for that reason we have not included our cases nor the literature upon this subject in this paper.

ANATOMICAL EXPERIMENTS

Because the cases observed by us seemed to differ so materially in their clinical manifestation from the descriptions of such lesions as given by the various writers upon fractures of this region, a group of fracture experiments were made upon cadavers placed at my disposal by Dr. Stoddard in the anatomical laboratory of the Cornell Medical School.

The scarcity of anatomical material and the remote possibility of being able to produce a clear-cut type of the bone lesion by external violence applied to the shoulder region led me to make the fracture line to be studied with an osteotome. Such attempts as I did make resulted in fracture of the neck of the humerus. The lines of fracture produced in these experiments were confined to the types we had seen in the clinical cases, *i.e.*, (1) fractures of the surgical neck, (2) fractures of the lower half of the glenoid fossa, (3) fractures of the upper half of the glenoid fossa through the suprascapular notch.

Experiment I.—Aged female, right shoulder. After exposing the suprascapular notch from behind and above by removing the trapezius muscle, the neck of the scapula was fractured from the notch to the axillary border just below the glenoid tubercle with an osteotome, thus producing the type we had observed most frequently in the clinical cases.

By pressure over the joint of the shoulder the head of the bone was pushed a little farther beneath the acromion and the coracoid process somewhat closer to the midline. There was, however, no dropping of the head away from the acromion which could be corrected by lifting the shoulder upward. Traction in the cadaver allowed for certain slight displacements in various directions which could be explained by the stretching of the dead tissue, but this traction did not correct the displacement of the fractured fragment. This indeed seems most likely since the deformity is one of displacement mesialward of the whole shoulder-joint, and such deformity as occurs is due to the displacement of the head inward and very slightly forward, displacement being governed by the conoid and trapezoid ligaments, and coraco-acromial ligaments.

When the deltoid muscle was cut transversely the head dropped down 1 cm. This deformity was corrected by lifting up the elbow. The degree of downward displacement increased when the supraspinatus and the long head of the biceps were cut, and became much more pronounced when the joint was opened.

When the coracoclavicular ligaments were cut there was an increase in the width of the gap between the coracoid and the clavicle, and a deformity appeared in the acromioclavicular joint, but no change occurred in the relationship of the humeral head and the acromion.

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All these facts correspond with the statements of Fick, Morris, and the anatomists that the shoulder-joint is dependent upon the muscles and the atmosphere for its stability. With these muscles intact and the shoulder-joint unopened a fracture through the neck of the scapula does not produce a deformity which can be influenced by the methods described for the treatment of this type of fracture.

Dissection showed that the glenoid fragment was displaced very slightly inward and the fractured surface of the neck was anterior to and slightly overlapped the line of fracture in the body. This corresponds to the displacement in Morestin's case. The amount of this displacement mesialward was controlled by the coraco-acromial and the coracoclavicular ligaments, especially the former. It was difficult to estimate the amount of tearing of the coraco-acromial ligament which was essential to increased displacement, but by partially severing it an increase of 0.5 cm. could be made in the displacement mesialward.

This would strongly suggest that in the cases with much displacement the coraco-acromial ligaments are more or less torn.

Experiment II.—Exposure of the suprascapular notch as in Experiment I. With the osteotome a fracture line was made through the notch to the middle of the glenoid behind the base of the coracoid.

When this was done there was no appreciable change in the shoulder contour. Pressure was then made upon the head of the humerus by crowding it inward without producing any appreciable change at the shoulder other than a slight increase in the prominence of the coracoid process. Traction upon the arm caused a little change at the outer end of the clavicle which seemed to become very slightly more prominent, a fact which might be explained by the stretching of the dead tissues. Pressure over the coracoid gave a certain amount of mobility not present on the opposite side. When the deltoid, supraspinatus, and biceps were cut and the joint opened, the same phenomena which were described in Experiment I occurred. When the conoid and trapezoid ligaments were cut the outer end of the clavicle became more prominent, and this prominence increased when the capsule of the acromioclavicular joint was opened. All the above could be corrected by raising the arm upward, but, as can be seen, all the displacements were due to other forms of injury than the fracture and practically no effect resulted from raising the arm or from traction upon it when the fracture alone existed. Dissection showed very little displacement along the line of fracture other than a tilting forward of the lower end of the coracoid fragment.

The case in our series was not a simple fracture of the above type, but combined a dislocation of the outer end of the clavicle (rupture of the coracoclavicular ligaments) and the deformity was really due to that injury.

Experiment III.—Fracture line from the middle of the glenoid fossa to the axillary border of the scapula (type of Cases V and VI in our series).

It was more difficult to produce this type, inasmuch as approach to the area it was desired to fracture meant disturbance of some of the muscle relationships at the joint and also allowed the entrance of air into the joint unless considerable care was used. The method of approach which caused the least disturbance was that from the back, cutting through the infraspinatus and teres minor to a degree sufficient to allow the osteotome to be used.

A line of fracture was then made which compared very favorably to that

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of our Case VI, *i.e.*, from just above the middle of the glenoid to the axillary border along the attachment of the triceps. There was no change in the position of the head of the bone and no change in shoulder contour. Pressure downward upon the head and traction upon the arm produced some displacement of the head due to the stretching of the dead tissue. Cutting the deltoid, etc., as described in Experiment I, produced the same increase in the displacement described there. Raising the arm did not change the position of the fragment. Traction on the arm in the abducted position produced a further widening in the gap between the fractured surfaces. In the cadaver it was possible to feel this movement in the fragment by high palpation in the axilla, and to confirm it by watching the movement of the fragment from the opening made in the back to produce the fracture.

From the above-mentioned clinical observations and anatomical experiments we may conclude:

1. That the description of the deformity resulting from fracture of the region of the neck of the scapula as ordinarily given is not correct and that fracture in this region may occur without any recognizable deformity.
2. That the clinical manifestations of the fracture are insufficient to make a positive diagnosis, and that the X-ray is an essential factor in the diagnosis.
3. That immobilization of the arm by a Velpeau or similar bandage is all that is essential, and that no manipulative efforts have any effect upon the displacement which occurs at the line of fracture.
4. That massage, baking and careful attention to the after-treatment will give practically perfect functional result.
5. That the resulting function is so satisfactory that ill-advised attempts at correction are to be condemned. Should a type of fracture occur in which the displacement actually promised a bad functional result, the fracture line could be best approached from behind and the glenoid fragment pried into position in this way with correction of the coincident injuries by appropriate methods (repair of ligaments, etc.).

LITERATURE—REPORTED CASES

The literature is replete with fairly numerous cases reported as fractures of the regions under discussion. We propose to classify these cases into three classes, namely, specimens and autopsy reports, cases with X-ray confirmation, and clinical cases without either of the above types of confirmation, because we do not feel that those cases in which the diagnosis rests upon clinical evidence alone, unsupported by postmortem, X-ray, or operative confirmation, can safely be included in any collected list of such injuries.

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TYPE I.—*Fracture of the surgical neck:*

CASE I.—Baudoin describes a prehistoric specimen. In excavating at Belleville a burial chamber of the Neolithic Period among other abnormalities in the bones of about fifty skeletons, a scapula was found showing an evident fracture of the surgical neck. Report was made on account of the evident rarity of the injury, and from the fact that there is not a single museum specimen in France. Repair had been complete, but from the remains of the callus it was evident that the fracture had detached the glenoid in its entirety with a small part of the axillary border of the scapula. There was also a fracture of the base of the coracoid. The distal fragment was displaced inward and backward, the glenoid cavity being rotated backward on its vertical axis. Posterior to the glenoid there was thrown out a peri-articular wall of bone by means of which the function of the joint had evidently been preserved. As there was evidence of complete repair, it follows that there can be a spontaneous cure, for at this period there was no rational therapeutics.

CASE II.—Similar to Case I is the specimen in the Royal College of Surgeons, mentioned by Flower. In this case also there had been complete bony repair.

CASE III.—Thomas Bryant illustrates a specimen (No. 1097) in Guy's Hospital Museum. The fracture line extends from a little to the inner side of the suprascapular notch to below the glenoid.

CASE IV.—Mott, Valentine: A specimen of fracture of the neck of the scapula. The clavicle was also fractured.

CASE V.—Du Verney: A girl of twenty fell into a quarry, where she was found dead. Autopsy revealed fracture of the neck of the scapula including the coracoid, there being a complete separation from the remainder of the bone. This is the first recorded case verified by dissection.

CASE VI.—Neill exhibited before the College of Physicians of Philadelphia a specimen of healed fracture of the scapula, the fracture involving the glenoid cavity and running longitudinally through the neck so as to traverse the base of the coracoid and spinous processes and a portion of the upper margin of the bone. The specimen illustrated the manner in which the repair of the bone had been effected.

CASE VII.—Morestin describes a specimen from a cadaver, there being no history. The cause of death was pulmonary tuberculosis. Exteriously there was no sign of injury nor was there any limitation of motion. The line of the fracture extended from the suprascapular notch to 3 cm. below the glenoid and apparently had been slightly oblique, from behind forward and outward. The distal fragment had ridden slightly over the proximal and union had occurred in this position. The ligament across the suprascapular notch had not been ruptured, nor apparently had the conoid, trapezoid, and coracoid ligaments.

CASE VIII.—Cavaye: A workman while raising a huge stone was struck on the shoulder from behind by the lever. At autopsy, in addition to other injuries, was found a line of fracture extending from a little within the suprascapular notch to a point 2 cm. below the glenoid, skirting the base of the coracoid.

CASE IX.—Cotton: Radiograph of fracture of the surgical neck. There was no history of the case.

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CASE X.—Scudder: Radiograph of fracture of the scapula behind glenoid.

CASES XI-XX.—Grüne reports ten cases of fracture of the surgical neck of the scapula, diagnosis confirmed in every case by radiograph. In only one was there any displacement. In this one the distal fragment was drawn up over the proximal, as in the specimen described by Morestin, though to a less extent. Deformity was usually absent but when present was limited to a slight flattening of the deltoid. He calls attention to the fact that this fracture may result from relatively slight trauma. In one of his cases a woman of sixty fell out of bed on her right shoulder. He describes a case in which the fracture was the result of indirect violence. A laborer was carrying one end of a heavy load when his helper suddenly dropped the other end. In an attempt to hold up the weight alone, he felt a sudden pain in the right shoulder and heard a crack. X-ray showed a transverse fracture of the neck of the scapula. The published radiographs are so indistinct that it is impossible to make out the line of fracture, but from the description it is evident that the fracture was unusually incomplete and that the line was not always in what is usually understood by the term "surgical neck." In diagnosis he emphasizes tenderness to pressure in the region of the scapular neck. In the treatment he uses dorsal decubitus with traction in extreme abduction after the method of Bardenheuer for ten to fourteen days, usually with passive motions daily. Subsequently passive motions and massage.

The results were excellent, there being practically perfect function in all but one case, usually in three to six weeks.

CASES XXI-XXIII.—Plageman reports three cases from radiograph, but does not give details nor reproduce the pictures.

In addition to the well-authenticated cases described above there are numerous reports of cases in which the diagnosis rests upon clinical evidence alone. Among these may be mentioned the reports of Alix, Broadhurst, Bramwell, Brown, Bell, Cross, Dugas, Ashhurst, Skey, Stimson, Harris, Monagan, Fitzgerald, Parker, Gerster, Stillings, Holmden, Hamilton, Bulloch, and Longlet. In a large proportion of these cases the injury resulted from a severe trauma and was complicated. In four cases there was more or less complete paralysis of the upper extremity from injury to the brachial plexus; in five cases there was some interference with the circulation; in two there was a coincident fracture of the upper portion of the humerus; in one a fracture of the outer end of the clavicle.

The liability to error in a diagnosis which rests alone upon physical signs may be deduced from the fact that of three of the cases upon which Sir Astley Cooper based the picture of this condition which has since become classical, the two which subsequently came to autopsy proved to be fractures of the upper extremity of the humerus.

Summary.—Cases confirmed by specimens and autopsy, 8; cases confirmed by X-ray, 15; total, 23. Our cases, 5; total, 28.

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TYPE II.—*Fracture of glenoid, line of fracture extending from within the glenoid cavity to the axillary border of the scapula:*

CASE I.—Spence and Steel report the case of a man who, while intoxicated, injured his shoulder by a fall. The deformity was that of the classical fracture of the surgical neck of the scapula, and the normal contour of the shoulder was restored by upward pressure on the elbow, the restoration being accompanied by crepitus. The patient died on the nineteenth day from a coincident head injury.

At the autopsy the concourse of the scapular fracture extended diagonally upward and downward from about $\frac{1}{2}$ cm. back to the origin of the long head of the triceps, and separated the neck as well as the lower four-fifths of the articular surface of the glenoid. The long head of the biceps and the whole glenoid ligament were torn from the upper remaining fragment of the articular cavity as well as from the otherwise injured capsular ligament, and had followed the displaced portion, thus separating all the articular structures from the scapula and drawing them downward.

CASE II.—Struthers: A woman of twenty-one tripped while walking and fell on the front of her shoulder. Examined four days after the injury. Complained of pain and disability in the right shoulder. There was noticeable absence of swelling and ecchymosis. Close inspection only revealed deformity, a slight flattening of the deltoid. Complete loss of power of voluntary motion, not due to paralysis of muscles, as they could be felt to contract. The fracture line extended from just below the middle of the glenoid to the upper portion of the axillary border. The fracture was evidently caused by the head of the humerus being driven against the fossa, detaching the lower portion. The head of the humerus had not fallen, being presumably held by the upper portion of the joint capsule, the long tendon of the biceps, and the supraspinatus. The treatment was daily passive movements, massage, and, on account of discomfort, a sling for a few days. The patient was encouraged to use the arm as much as possible. Three weeks after injury she could swing the arm to vertical but could raise or lower it slowly. Seven weeks after the injury she could lift or lower the arm slowly without limitation of range, but the arm was not quite so strong as on the sound side.

CASE III.—Beasley reports the case of a man who came to him after having been treated for fracture of the surgical neck of the humerus. The left arm was wasted and had no motion save a very limited one forward and backward. The humerus was intact, rotating freely in joint cavity, but on attempt at elevation seemed locked at upper end. There was felt in the axilla a fragment from the glenoid. The radiograph showed a fragment broken from the lower end of the glenoid which had dropped down and had been lifted up just enough, when united, to push up the head of the humerus against the acromion, blocking it. Under ether the adhesions were broken up and the fragments pushed into place, after which the arm could be put through the normal range of motion. Passive motion in one week, and recovery.

Summary.—Cases confirmed by autopsy, 1; cases confirmed by X-ray, 2; total, 3. Our cases, 2; total, 5.

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TYPE III.—*Fracture of the glenoid, fracture line extending from within the glenoid cavity upward and inward, usually including the coracoid:*

CASE I.—Braun found, in the course of an autopsy on a man who had been struck but not run over by a locomotive, a fracture of the coracoid process which included the upper portion of the glenoid cavity.

CASE II.—Avray reports autopsy on a case of severe injury in which, in addition to fractures of numerous ribs, there was a complex fracture of the scapula including the glenoid, the upper fragment being about $\frac{1}{4}$ inch wide and free from the coracoid, which was also fractured.

CASE III.—Preiser describes a type of fracture somewhat similar to the one described by Braun. It is also usually associated with a fracture of the outer end of the clavicle. The mechanism is peculiar: the patient, while carrying a burden, slips and falls, catching himself upon his arm stretched backward and somewhat abducted. As the arm is abducted and held backward the force falls, not on the acromion, but on the coracoid. The scapula being fixed by involuntary muscular action, the coracoid is torn off with the upper part of the glenoid. The fracture of the glenoid is usually star-shaped, the fissure extending through the supraspinal fossa either to the vertical border of the scapula or to the middle of the superior border. The coracoid strikes the clavicle and causes a tear of the acromioclavicular ligaments, causing a dislocation of the acromial end of the clavicle or, if these ligaments hold, a fracture close to the acromial end of the clavicle.

The second form (line extending from within the glenoid to the superior border of the scapula) is represented by the picture of a specimen in which the fragments had healed. He speaks of another case but states that the radiographs are not such as to permit reproduction.

CASE IV.—Kolliker gives a picture of a specimen, the counterpart of Preiser's cases. He says that the fracture of Preiser may be considered an incomplete fracture of the surgical neck and corresponds to the splitting off of the lower half of the glenoid, which can also occur only when the arm is in one definite position.

Summary.—Autopsy and specimens, 4; X-ray, 2; total, 6. Our cases, 1; total 7.

TYPE V.—*Fissure extending from within the glenoid cavity:*

CASE I.—Assaky: A man of twenty-five fell on his left shoulder. He was brought to the hospital, where the diagnosis of subcoracoid dislocation of the shoulder was made and the deformity reduced. Twenty-eight days later the patient died of pneumonia. At autopsy the head of the humerus occupied the glenoid cavity; there was no malposition nor tear of the capsule. A stellate fracture of the glenoid with three arms was found. Also there was a fracture of the acromion at the juncture of the neck with the spine. There was no evidence of consolidation in the fracture of the glenoid.

CASE II.—John Poland showed before the Hunterian Society a specimen of fracture of the glenoid from a man aged forty-six who had fallen a distance of about twelve feet, dying from injuries of the head. The glenoid cavity was

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fractured in a stellate manner and three lines of fracture radiated from this in the body of the scapula. The acromion process was also broken, but there was no dislocation.

CASE III.—Plageman (*loc. cit.*) cites three cases from the study of radiographs described as fractures of the anatomical neck with fissures into the joint. He does not reproduce the pictures, and the diagrams do not seem to indicate the fracture line he describes.

TYPE VI.—*Fracture line extending immediately behind and parallel with the glenoid through that compact portion of bone on which the glenoid rests, which is called the "anatomical neck":*

The only cases of this type in which diagnosis was confirmed by X-ray or autopsy are the three cases mentioned by Plageman. The radiographs upon which the diagnosis was founded are not reproduced and the cases are not described individually. There is no anatomical specimen nor record of any autopsy of this condition. Cases in which diagnosis rests on clinical evidence alone are reported by Dugas, Hemenway, and Eales.

Since this paper was submitted for publication the following additional case has come under observation:

On November 1, 1915, an Italian laborer, forty years old, was carrying a small iron beam, over his right shoulder, down an inclined plane when he slipped and fell forward, the right shoulder being caught between the falling beam and the floor. He was removed in the ambulance to the Hudson Street Hospital, on the service of Dr. J. H. Kenyon.

There was marked swelling and some ecchymosis over the dorsum of the scapula; bony crepitus was distinct and there was an evident comminuted fracture of the body of the scapula. Disability was complete though passive motion was possible, at the expense of considerable discomfort.

On the third day after injury active motion of the shoulder-joint was possible to a limited extent and the complete range of motion could be carried out passively with slight discomfort. The swelling over the dorsum of the scapula persisted to some extent, but there was no flattening of the deltoid. Crepitus was elicited, but was evidently due to the fracture of the body of the scapula.

An adhesive band was placed over the scapula and the arm was carried in a sling so arranged as to support the elbow. After five days the adhesive was removed, the only subsequent treatment being a sling. After ten days he was encouraged to use his arm. Three weeks from the date of injury he could carry his arm through the full range of motion, complaining only of slight sore-

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ness. One month after injury he complains of no pain, but thinks his arm is not quite as strong as it was before he fell.

This case was regarded as being merely a fracture of the body of the scapula, until the radiograph was seen. Even when we knew that there was in addition a fracture of the surgical neck we could make out no deformity of the shoulder and the only symptom was pain on motion.

The X-ray shows a fracture through the surgical neck (House of Relief No. 3134) with lines of fracture in the body adjacent to the neck similar to Case II in our series.

This additional case makes six cases of fracture of the surgical neck of the scapula reported by us and increases the total of the cases of this type to 29.

The following additional literature upon this subject has come to our notice since the presentation of this report:

Bonnet et Becquelin (*Bull. de la Soc. Anat. de Paris*, 1896, p. 845, 5 serie, vol. x): A laborer aged forty years was struck on the shoulder by a railroad truck weighing 2000 kilogrammes. In addition to other injuries there was found at autopsy, a fracture of the scapula. The bone was in two principal fragments, the smaller comprising the glenoid, the adjoining parts of the supra- and infraspinous fossæ, the origin of the spine of the scapula and the coracoid. The latter was, in addition, fractured at the base.

Ziegler (*Muenchener Med. Wochenschrift*, April 18, 1899, p. 515) reports a case of fracture of the surgical neck of the scapula, which was complicated by rupture of the axillary artery and resulting gangrene of the upper extremity. The fracture was observed at the time of the amputation at the shoulder.

Tanton (*Nouveau Traité de Chirurgie*, by Le Dentu et Delbet, 1915, vol. iv, p. 794) reproduces radiograph of fracture of the surgical neck of the scapula and gives a good description of the lesion here discussed.

Lotzbeck (*Deutsche Klinik*, 1867, vol. xix, p. 420) reports two cases of fracture of the neck of the scapula, one of the surgical and one of the anatomical neck, the diagnosis resting on clinical evidence alone.

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TRANSACTIONS
OF THE
PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting, held October 4, 1915

The President, DR. JOHN H. GIBBON, in the Chair

FRACTURE OF THE OS CALCIS

DR. NATHANIEL GINSBURG related the details of four cases of fracture of the os calcis. The first two of these were observed and treated by him through the courtesy of Dr. Edward Martin. Their histories are as follows:

CASE I.—Case No. 10468. M. I., male, was admitted to the Mt. Sinai Hospital on April 4, 1915, and discharged on May 20, 1915. He had jumped out of a second-story window to escape from a fire, and landed on the heel bones of both feet. He was immediately brought to the hospital, unable to stand, with severe pain, swelling, and discoloration of the entire posterior portion of the foot and lower leg. X-ray showed present fracture of both ossa calcis. The patient remained in the hospital about six weeks and was finally discharged able to go about on a cane and crutch. He died six weeks ago of heart disease.

CASE II.—Case No. 10690. A. M., male, was admitted to Mt. Sinai Hospital on April 18, 1915, and discharged May 27, 1915. He fell from a step-ladder, alighting on the heel-bone of the right foot, and sustained a fracture of the os calcis. He now walks with a cane and has pain on the outer side of the foot below the external malleolus.

CASE III.—Female, aged thirty-five years, was admitted to Dr. Ginsburg's service at the Jewish Hospital, June 22, 1915, having fallen through a skylight to the floor below, landing upon both feet. She sustained a fracture of the left os calcis and a transverse fracture of the internal and external malleoli of the left tibia and fibula without separation of the latter fragments. In addition she sustained a fracture of the external tuberosity of the right tibia, the line of fracture running into the knee-joint, and a fracture of the adjacent head of the fibula with some impaction. This type of fracture of the tibia in this region is of rare occurrence. The patient was put to bed with moderate extension by traction appa-

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ratus on the right leg, not sufficient, however, to separate the fragments but merely to prevent contact of the knee-joint surfaces.

The displacement of the os calcis was regarded as one which could not be markedly improved by operation or by much manipulation, and the foot and leg were put at rest in a fracture box and an ice-bag was applied to the seat of fracture, and after much of the swelling had subsided a light plaster case was applied enclosing the foot and leg. The fracture of the os calcis was of the comminuted type, involving the anterior extremity of the bone with some cortical tearing of the posterior plantar portion.

CASE IV.—Male, admitted to Dr. Ginsburg's service at the Jewish Hospital June 24, 1915, and discharged August 8, 1915. This patient fell down a casement and was admitted to the hospital suffering from fractures of the left humeral anatomical neck and a T-fracture of the left radius at the wrist-joint. The latter fracture showed some impaction and was apparently accompanied by a fracture of the styloid process of the ulna.

Under ether anæsthesia abduction and extension of the humerus at right angles to the body was maintained by a plaster case enclosing the thorax and the arm. The extension was maintained in bed by a traction apparatus similar to that applied in treating a fracture of the femur. A radiographic examination showed little improvement in the position of the fragments, the head of the humerus being elevated and rotated outward and the lower fragment being drawn upward and inward into a high axillary position. The plaster case was removed, the arm dressed to the side of the chest wall with a high axillary pad and a weight extension from the elbow. Good union in good position resulted, the movements of the shoulder-joint being excellent. The impaction of the lower end of the radius was broken up and a light plaster case applied, succeeding a Bond splint which was primarily employed. There is now little anatomical deformity and practically normal function of the hand.

Dr. Ginsburg remarked in connection with these cases that fracture of the os calcis is regarded by Cotton as being the commonest injury (fracture) of the tarsus. Three types of this fracture are commonly observed: (1) one being a fracture of the bone at the osseous attachment of the Achilles tendon; (2) a second type is a simple fracture of the sustentaculum tali; (3) and a third type, one which he had had the opportunity to observe in a number of patients, is a comminuted fracture of the body of the bone due to a compression force sustained by falling or jumping from a height and landing on one or both heels. This latter type is the one observed with greatest frequency. The dis-

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ability resulting from fracture of the os calcis, especially of the comminuted type, is unquestionably a very severe and lasting one; in many instances the bony contour of the foot being so seriously disturbed as to permanently disable the patient. In this type of fracture of the body of the os calcis the molecular disintegration takes place approximately near a vertical line just in front of or through the posterior articulation between the astragalus and the os calcis. The comminution of the bone may be severe enough to result in a few fragments or in almost total disintegration of the body of the bone in the region injured. The lines of fracture may have a stellate appearance running off in various directions. The displacement resulting from a comminuted fracture about the middle of the os calcis, or anterior to a vertical line drawn through the middle of this bone, is apparently the result of the dropping down of the inner border of the foot, owing to the lack of bony support at this point, and also due to some "diminution of the total depth of the bone," especially of its forward end (Cotton). Should the displacement of fragments resulting from a fracture result in an irregular contour of the plantar surface of the os calcis, a painful foot will result, simulating the condition found in exostoses of the os calcis from other causes.

A fracture of the contiguous dorso-inferior articular portion of the scaphoid bone may result, if the compression force sustained producing the fracture is partly borne by this bone.

The diagnosis of this fracture can be made in most cases by a history of the accident sustained, which is usually a fall or a jump from a height, the patient landing on the feet. Much swelling and some distortion of the normal outlines of the foot in this region promptly take place. The swelling is often so marked, and manipulation is accompanied by so much pain that it is hardly justifiable to attempt a diagnosis by examining for mobility or eliciting crepitus of the fragmented bone. The radiologic examination is the important one both for diagnostic and prognostic value.

The immediate and diffuse swelling, accompanied by much pain and tenderness, is so marked that little can be done except to put the foot at absolute rest in a fracture box with an ice-bag or sedative lotion applied to the part. From radiographic study of the injury it can be determined if improvement in the position of the fragments is possible by the employment of an anæsthetic. If, however, the bony outlines are fairly well preserved, union will take place with a resultant good position of the heel, but with some tendency toward dropping of the inner posterior aspect of the foot. If indicated, tenotomy of the Achilles tendon should be done early to assist in mobilizing the posterior

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fragment in order to reestablish the morphological outline of the bone.

DR. JAMES K. YOUNG said that this fracture is more common than is usually supposed. It is apt to occur when a person falls from a height and lights on his feet. One might expect it to occur from lateral crushing, as when a horse rolls on a rider's foot. In such accidents, however, and in automobile collisions the astragalus is more apt to be the bone fractured. He had seen a number of these cases several weeks after the injury and suggested more thorough treatment at the time of the injury in order to avoid the subsequent flat-foot and deformity of the ankle. Under an anæsthetic reduction should be made promptly by reimpaction of the fragments, with the hands or with a mallet and sandbag, after the method of Cotton. After the reduction, one felt pad should be placed over the dorsum, one over the os calcis and tendo Achillis, and one under the plantar arch, and, with plantar flexion of the foot and flexion of the knee, the foot and leg to the upper third of the thigh should be placed in a plaster-of-Paris cast for two weeks, after which manipulation and other remedial measures should be used.

T-FRACTURE OF THE LOWER EXTREMITY OF THE RADIUS

DR. H. A. McKNIGHT (by invitation) presented a man forty-six years of age, whom he had seen in Dr. Booth Miller's clinic at the Polyclinic Hospital. The man, August 18, 1915, fell eight feet from a ladder, landing on his side and left arm, and in falling jammed his left closed fist against an iron beam; on recovering from the effects of his fall he noticed soreness and slight swelling of his left wrist.

Six days later the reporter saw him; he still complained of soreness and pain on motion. Examination showed increase in the anteroposterior diameter of the wrist, although this thickening was an uncertain diagnostic sign, as he had broken the other arm twice before, so no comparison could be made. The styloid processes were in proper alignment, but wincing tenderness was elicited along the radial shaft and on extreme abduction over the ulnar styloid.

The X-ray revealed (Figs. 1 and 2) an impacted fracture of the lower end of the radius with two linear splits extending upward for about one and one-half inches and nearly parallel with each other, being separated by an interval of a quarter of an inch below and one-eighth above, thus converging from below upward, a fracture of the ulnar styloid and a slight posterior displacement of the distal radial fragment. The skiagram shows complete impaction of the radial fragments which to a casual observer would present no abnormality, but the lateral view

FIG. 1.

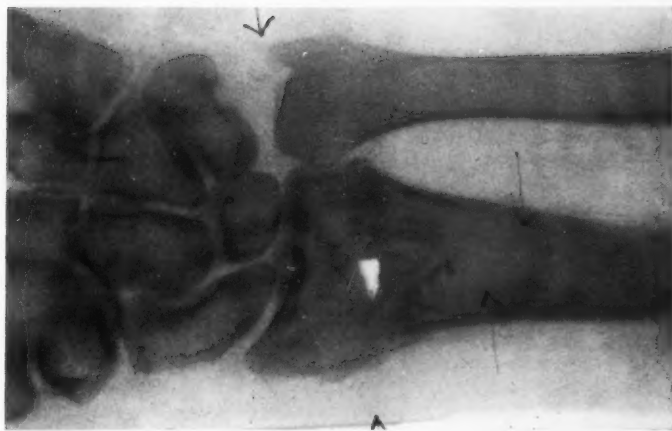
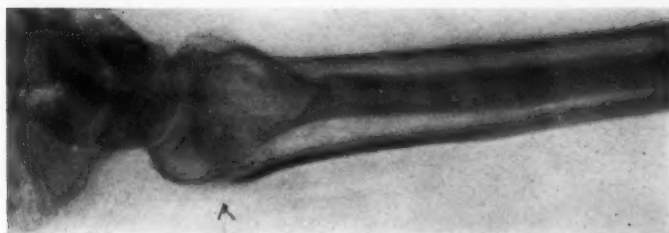


FIG. 2.



FIGS. 1 and 2.—Impacted fracture of lower end of radius with linear splitting.

FIG. 3.

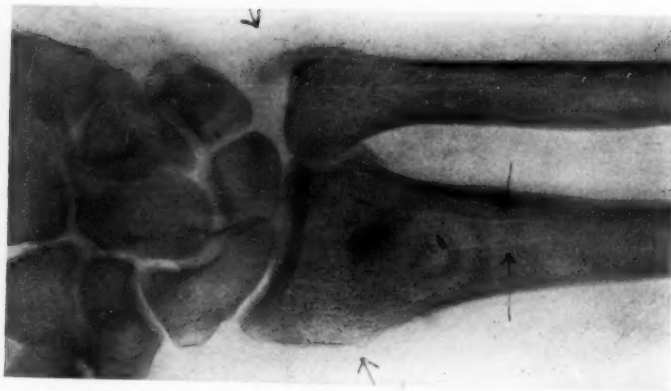
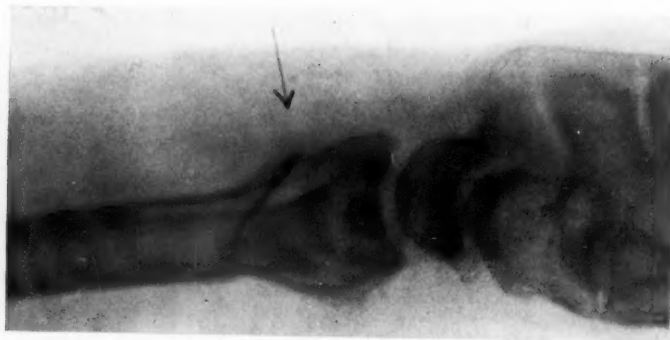


FIG. 4.



FIGS. 3 and 4.—Fracture shown in Figs. 1 and 2, after reduction.

FRACTURE OF RADIUS

(Fig. 2) shows the line of the radiocarpal articulation tilted backward instead of facing slightly forward as it does normally. The impacted fragments were separated under gas, and the arm splinted with a Bond and a posterior straight splint.

Skiagrams taken two days later (Figs. 3 and 4) show the arm after reduction; the transverse fracture is more distinctly shown, although the linear cracks are not so easily seen. The radiocarpal joint line is now normal and faces slightly forward instead of backward.

Dr. McKnight added that uncomplicated longitudinal fractures in this position are rare, only nine cases having been reported, and he had found none in which an impacted Colles's fracture was also present.

Bigelow in 1858 reported a stellate fracture of the lower end of the radius extending along the shaft, and Cotton in 1910 stated that, "So far as we know this fracture is the result of direct violence by crushing. It is rare, three specimens constitute the total of evidence." Since then Parrish, Bendell Wilhoit and Skillern have presented fractures of the radius, and Dr. Miller has seen one case caused by the direct violence of a window falling on the wrist.

The clinical diagnosis is difficult and has only been made heretofore by means of the X-ray, although the symptoms in the cases reported present marked similarity. There is usually a history of direct violence; clinical examination reveals slight swelling and tenderness along the line of the shaft, but no deformity. Treves reports a case in which he claims he felt a vertical linear ridge but was unable to make a definite diagnosis without the X-ray which showed a longitudinal fracture extending upward for about two inches.

In cases of direct violence due to direct force in the line of splitting the mechanism is simple. The scaphoid and semilunar are driven upward and outward by the upper end of the os magnum, causing a cross strain against the lower articulating end of the radius with resulting split. The further complication of a fractured ulnar styloid is not unusual, as 66 per cent. of fractures of the radius are complicated by this added fracture.

This case is of interest due to its rarity. The diagnosis in uncomplicated cases may be suspected clinically by analysis of the history plus a vertical linear area of wincing tenderness.

DR. JOHN B. ROBERTS showed two skiagraphs of a recent fracture of the lower end of the radius. They show a splitting off of a portion of the posterior lip of the articular surface very much in the direction described by John Rhea Barton. A good many medical men confuse the various fractures at the base of the radius with that described by

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Colles of Dublin, which he considered to be an injury occurring about an inch and a half above the joint. It would be better to call a fracture at this point a break in the lower fifth of the shaft. The displacement is usually backward, but may be reversed so that the upper end of the lower fragment is directed forward. Almost all physicians give the name of Colles to all fractures of the lower end of the bone, whether they be at the point described by him, or the so-called classic fracture through the base of the radius with backward displacement. The latter was considered up to the time of Dupuytren a probable posterior dislocation of the carpus. Both the classic fracture and the true Colles's fracture have usually a backward displacement of the upper end of the lower fragment, but both of them may be reversed, the lower fragment being displaced backward at its lower end.

BONE TRANSPLANTATION

That no two fractures can be treated alike is a certainty. Each fracture is treated according to the individual status of that special case. Every Colles's fracture cannot be treated on a Bond splint, a Levis splint, a Palmer splint, a posterior splint, between two splints, or in a cast. Nor can every Pott's fracture be treated in a fracture box, on Dupuytren's splint, or in a cast. The treatment of each is adapted for the individual case. The same is true of the open treatment of fractures. Lane's plates, silver wire, catgut mesh, Parkhill's clamps, bone transplants, etc., each has its own advantages or disadvantages, and no one method can be used in every case.

In two of the cases cited below it was necessary to digress from the usual method of treatment. The principle of each seems sound.

DR. HUBLEY OWEN related two cases of fracture in which bone transplantation was employed in their treatment.

CASE I.—Miss S., aged twenty-six, fell downstairs on October 21, 1914, and sustained a dislocation of her left elbow, and a fracture of the lower third of the radius of the same arm. She was treated by her family physician and subsequently returned to her occupation, that of a stenographer, at the end of five weeks. Because of stiffness of her elbow and inability to properly supinate her left hand in order to typewrite, she was referred to reporter in January, 1915.

An X-ray was taken at that time, and showed an unreduced dislocation of the head of the radius and a fracture of the lower third of the radius, with vicious union. The lower fragment was displaced upward and inward, and was united to the upper fragment and to the ulna. Supination and pronation were impossible.



FIG. 5.—Bone transplant to fill defect in radius ; condition at time of operation.

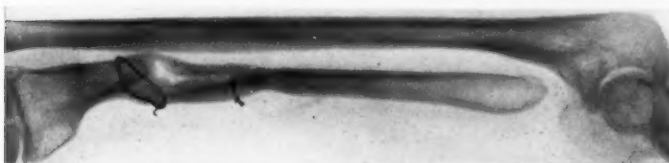


FIG. 6.—Final result of case shown in Fig. 5.



FIG. 7.—Deformity after fracture of forearm.

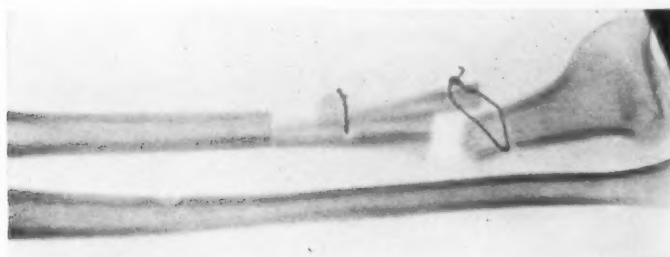


FIG. 8.—Fractured forearm, bone fragments dovetailed and secured by silver wire.

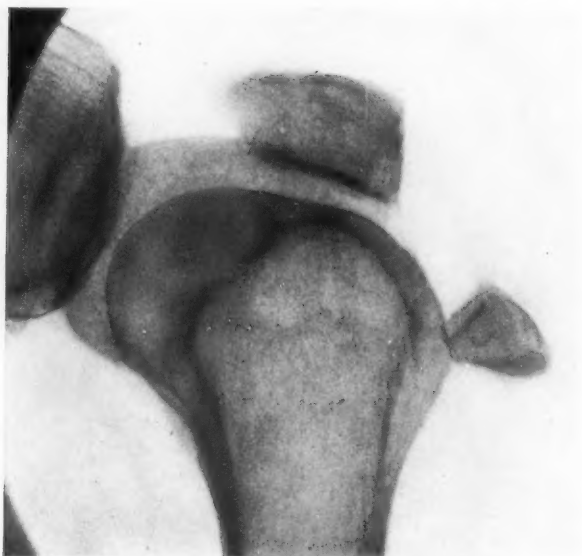


FIG. 10.—Fracture of patella.



FIG. 11.—Result of non-operative treatment.

BONE TRANSPLANTATION

On January 24, 1915, he removed the head of the radius, and attempted to correct the deformity of the broken radius. After he had separated the two fragments, and had also separated the lower fragment from the ulna, and straightened the wrist, he found that when the fragments of the radius were in alignment there was a gap of about an inch between the fragments. A transplant was then taken from the upper fragment, which was one-half the diameter of the bone. He was unable to transplant this into the lower fragment, so, as shown in the X-ray (Fig. 5), the transplant was merely laid alongside the two fragments and wired thereto. The second X-ray (Fig. 6) shows union of the two fragments.

The excision of the head of the radius gave her good motion in her elbow, and she now has good pronation and supination of her forearm.

There is some eversion of the hand, which can be corrected by the excision of a small part of the shaft of the ulna.

CASE II.—J. D., aged fifty-six, tripped and fell downstairs in July, 1915, and sustained a fracture of both bones of the left fore-

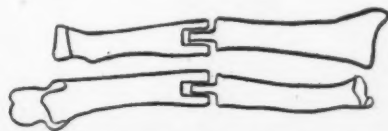


FIG. 9.—Diagram showing method of dovetailing bone fragments together.

arm. He was admitted to the Philadelphia Hospital three days after his injury, with the deformity as shown in the X-ray (Fig. 7). Two attempts were made to reduce the fracture with an anæsthetic. Both attempts were unsuccessful. Traction was then tried, but also failed.

He was operated upon August 10, 1915, and the attempt was made to hold the bones in alignment by dovetailing the ends of the fragments into each other. With a Gigli saw an oblong piece of bone was cut from the lower fragment, and, with the same implement, the upper fragment was cut so that it would fit into the groove of the lower fragment. He then supplemented this by silver wire, as shown in the X-ray (Fig. 8). The bones are uniting nicely.

Fig. 9 shows the manner in which the fragments were cut.

CASE III.—H. P., aged forty-six, fireman by occupation, fell in July, 1905, on his right knee, and sustained a fractured patella. He was treated at the Pennsylvania Hospital. He was not operated upon, but the fragments were held together by means of

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adhesive plaster. At the present time he has fibrous union (Fig. 11) but has absolutely good function of his knee.

In November, 1913, while working at a fire, he fell and sustained a fracture of the left patella. He was operated upon at the Jefferson Hospital, and the patella was wired.

He again fell, September 26, 1914, broke the silver wire and refractured his patella. The case was in the service of Dr. J. Chalmers DaCosta, who advised against another operation.

X-ray plate (Fig. 10) shows the wide separation of the fragments of the patella.

By treatment with a brace, which was so constructed that he was given more motion in the knee-joint each week, he now has firm fibrous union (Fig. 11) between the fragments, has discarded the brace and has perfectly good use of his knee.

THE RATIONAL TREATMENT OF VARICOSE LEG ULCERS

DR. PENN GASKILL SKILLERN, JR., read a paper with the above title, for which see page 176.

HÆMATOMA IN THE SHEATH OF THE RECTUS MUSCLE FROM RUPTURE OF THE DEEP EPIGASTRIC ARTERY

DR. SPEESE reported the case of a woman, aged sixty-two, who was admitted to the Presbyterian Hospital with the diagnosis of intestinal obstruction. The patient stated that ten hours before her admission, she developed a sudden and severe pain in the abdomen. The pain began in a swelling, situated below the umbilicus, which had been present for one year and which had been pronounced an umbilical hernia by her family physician. The patient was in moderate shock, the pulse rapid and weak, temperature a little below normal, she complained of nausea and had vomited several times. On examination a large mass was found below the umbilicus. This was regarded as a loop of intestine, not in an umbilical, but probably in an interstitial, form of hernia, and operation advised for an apparent strangulation. An incision was made over the tumor, and on opening the sheath of the rectus muscle, a considerable quantity of fresh and coagulated blood escaped, the slightest manipulation causing profuse hemorrhage. After packing the area from which the hemorrhage arose, and on careful exploration, it was found that the muscle was soft and pulpy, infiltrated with blood, and greatly resembled a strangulated intestine. Finally, the spurting epigastric vessel was disclosed and ligated. The muscle was so degenerated that six inches was removed. Palpation through the peritoneum did not reveal any abnormalities, so that the abdominal cavity was not opened. The sheath

HÆMATOMA IN SHEATH OF RECTUS MUSCLE

of the muscle was carefully sutured and overlapped, and the patient returned to the ward in good condition.

During her convalescence she was questioned more carefully concerning the development of the tumor. She was positive that it appeared suddenly about one year ago, and that there was no strain, blow, or other form of traumatism to account for its origin. On several occasions the mass enlarged slightly and became painful, but never had been so painful as during the last attack. The patient suffered from chronic nephritis and myocarditis, which complications prolonged her convalescence. The wound healed well, seemed solid and there was no tendency toward the formation of a hernia when the patient was seen last, three months after the operation.

Several years ago the author reported before the Academy a case of perirenal hæmatoma, and this case seems to belong to the same group. In perirenal hemorrhage, a definite cause may be demonstrated, such as tuberculosis, neoplasm, traumatism and hæmophilia. The spontaneous form is probably due to chronic nephritis, the only pathologic lesion which has been demonstrable. The same facts apply to the few cases on record in which spontaneous hemorrhage occurred in the rectus or other muscles. Hæmophilia has been noted in some of the cases, in others, as in the case reported, chronic nephritis has been present, and this, along with degenerative changes in the arterial system, may have acted as the etiologic factor in the production of the hemorrhage. It is noteworthy that massive hemorrhage into the perirenal or retroperitoneal space usually excites symptoms suggestive of intestinal obstruction, and that the same symptoms may be produced by hemorrhage into the sheath of the rectus or other muscles.

DR. FLOYD E. KEENE said that the case reported by Dr. Speese was similar to one which came under his observation on Dr. Clark's service in the University Hospital and appeared as a post-operative complication. Hysterectomy was performed in the morning and no untoward symptoms followed the operation until late in the evening when, following an attack of violent vomiting, there developed symptoms of internal hemorrhage. Operation was immediately done and an extraperitoneal cast of blood-clot was found, the source of hemorrhage being from the ruptured right deep epigastric vein, which was ligated. The peritoneal cavity was opened and found to be free from blood.

DR. A. P. C. ASHHURST said that he had seen one such case at the Episcopal Hospital in the service of Dr. George W. Norris, in the case of a youth, aged seventeen years, who was admitted to the medical ward January 16, 1912. His illness had begun on January 13, with pain in

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the left chest, and on admission there was dulness and bronchial breathing at the base of the left lung. On January 18 the leucocyte count was 32,800. Dr. Ashhurst was asked to see him January 24. His temperature ran from 103° to 104° F., his pulse-rate was about 120, and his respirations were from 30 to 38. He was told that he had had a pneumonia at the base of the left lung, with pleural friction. There had been no abdominal symptoms except slight distention for the past several days. His bowels had been opened normally. Recently he was thought to have had pleurisy and perhaps pneumonia in the right lung. There had been no crisis. There were pneumococci in the sputum. The leucocytic count that day was 25,000.

The boy looked desperately sick; he was dyspnoëic, cyanosed, flushed, but clear in mentality. He could hardly speak, being very hoarse, with constant cough, and expectorating blood-stained mucopus. The left chest was strapped, and only dry, creaking râles could be heard. The right chest was dull high in the axilla, the breath sounds were well heard, and there were numerous very loud, moist and whistling râles. The abdomen was slightly distended all over; deep respiration was impossible without pain and coughing. In the right hypogastric region a poorly-defined mass was visible. This was very tender on sudden or deep pressure, and was surrounded by tympanitic areas on all sides. There was slight œdema of the overlying skin. There was no cutaneous hyperalgesia. The abdomen elsewhere was flaccid, but slightly distended. Peristaltic sounds were normal. No mass could be felt through the rectum. The bladder was empty.

Under local anæsthesia an incision was made over the swelling. On opening the anterior sheath of the rectus there was a discharge of liquid and clotted blood. The fibres of the rectus muscle were destroyed throughout the whole width of the muscle, and for a distance of about 2 inches longitudinally. The parietal peritoneum was opened, disclosing normal contents. The peritoneum was closed and the cavity in the rectus muscle drained with gauze.

The clots removed from the rectus muscle were examined by Dr. C. Y. White, Director of the Pathological Laboratories of the Episcopal Hospital; muscle fibres were still recognizable in the clot. Cultures of the clotted blood showed "a long chain strepto-diplococcus, not the pneumococcus."

The patient died three days later, January 27, 1912. Autopsy showed no peritonitis, but pneumonia and acute parenchymatous nephritis.

This case may well be classed as one of "spontaneous hæmatoma"

FOREIGN BODIES IN THE SMALL INTESTINE

of the rectus muscle, presumably due to metastatic infection by hæmolytic streptococci. He objected to the use of the term "rupture" unless there is evidence of injury.

FOREIGN BODIES IN THE SMALL INTESTINE

DR. GEORGE G. ROSS reported the case of a woman, aged thirty-five years, who was admitted to the Germantown Hospital, March 2, 1915, with a history of pain in the right lower abdomen. This had been marked during the last six months and was associated with soreness. Occasionally the pains were colicky. The pain was increased by stooping or turning in bed, and by walking. Painful and frequent urination; urine was cloudy at times; there was no leucorrhœa. Her appetite was good and her bowels regular. There were no gastro-intestinal symptoms; the heart and lungs were negative.

The abdomen was flat, no masses to be felt. Pressure in the right hypochondriac region caused pain in the right iliac fossa. There was marked tenderness over the entire right lower abdomen, especially pronounced over McBurney's point and just above the symphysis. Vaginal examination showed a movable uterus, with some retroversion and prolapse. There was a distinct tender mass to the right of the uterus.

The following information was obtained after the operation and this fact accounts for the incorrect diagnosis of tubo-ovarian abscess. She had been an inmate of the State Hospital for the Insane, to the authorities of which we are indebted for the following facts: Their diagnosis was constitutional psychopathy. She had attempted abortion in all four pregnancies. During the last pregnancy, three years ago, she had made almost constant attempts to empty the uterus. Among the methods employed were three boxes of Hooper's pills; gin and celery seed of which she took three quarts; and fifty cents' worth of Epsom salts taken in one day. On the advice of a clairvoyant she took a cupful of hot claret at the same time, soaking her feet in hot water containing a pint of chopped onions. She developed suicidal tendencies, one of her methods being the swallowing of pins, twisted bunches of hairpins, safety-pins, etc. After two years of treatment she recovered her mental balance and was discharged.

Operation.—Right rectus incision. The terminal ileum was bent on itself and the sides of the bowel were adherent to each other and the apex of the mass was adherent to the bladder. The knuckle of bowel contained a foreign body which felt like calcareous plates. This portion of the bowel was resected and lateral needle and thread anastomosis was made. The tubes and ovaries were normal. The wound was

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closed without drainage. The resected gut contained eighteen to twenty pieces of thin, blackened wire resembling Gem paper clips or curtain hangers. One clip had perforated the wall of the bowel and projected into the peritoneal cavity.

DR. ADDINELL HEWSON said that he had found in the dissecting room of the Polyclinic a cadaver in which two steel needles had been forced by the patient between the occiput and the spinal column through the foramen magnum into the medulla and which were stuck against the ventral margins of the foramen magnum. In addition the patient had two needles of the same character in the nasal cartilage in front of the nasal bones. Her stomach was of enormous size. The needles had been in the spinal cord apparently for a long time because they were rusted. The woman was an insane patient and was from the same hospital from which Dr. Ross's patient came.

TORSION OF THE OMENTUM

DR. GEORGE G. ROSS reported the following case: A woman, forty years of age, was admitted to the German Hospital, August 13, 1915. Her chief complaint was pain in the lower right abdomen. Her trouble began five days prior to admission with pain in the upper abdomen, soon becoming general. Two days later the pain had localized in the lower right quadrant. There were 6200 leucocytes, a temperature of 100° and a pulse of 108. There were no chills. Appetite, bowels, heart, lungs, and kidneys were normal. This was her first illness. Family history was negative. Husband and four children well.

Examination was negative with the exception of a point of marked tenderness at McBurney's point. An ill-defined mass could be made out in the lower right quadrant. A diagnosis of acute appendicitis with abscess was made.

Operation.—The appendix was found acutely inflamed and covered with lymph. The omentum was found twisted on its long axis for about eight inches, there being three complete twists. It was dark purplish-red, congested, but not gangrenous. The appendix and omentum were removed as was an epiploic appendix which had become adherent to the mesentery of the ileum. The recovery was uninterrupted.

GALL-STONE ILEUS

DR. JOHN H. JOPSON reported the case of a woman, aged fifty-eight years, who had suffered for a long time with what was termed indigestion. She had been sick a week before admission to the hospital. The onset was sudden, marked by pain and diarrhoea, and following

GALL-STONE ILEUS

this no movement of the bowels could be obtained for six days. For the purpose of relieving the obstruction she had been given enormous doses of cathartics, including citrate of magnesia, blue mass, castor oil, calomel and rhubarb, as well as high compound enemas and opium. Vomiting was frequent and had been fecal for more than 24 hours before admission to the hospital. She was in fair condition; pulse and temperature not materially altered, abdomen flaccid, no areas of tenderness. No tumor could be felt and the rectum was empty. The stomach when washed out was found to be full of fecal matter. As soon as the abdomen was opened, the obstruction was located in a loop of the ileum, lying down in the pelvis. It was recognized to be a gall-stone and was removed by linear incision of the bowel. The opening was closed in the usual manner by two layers of sutures. The stone measured three inches in length by three-quarters of an inch in width, was smooth, oval, of an olive color and weighed 25 grammes. The bowel contracted very much at the point of suturing, evidently from muscular spasm. There were numerous adhesions in the hepatic region and no attempt was made to explore further in this direction. The first examination of the urine had been reported negative, but a second examination two days after operation revealed the presence of sugar, and in subsequent examinations as high as 3 and 4 per cent. was present; also acetone and diacetic acid. The patient's condition was poor after operation and there was marked cardiac weakness and paresis of the bowel, which responded to the exhibition of eserine, after pituitrin had been given without result. Probably as a result of an old diabetes, there was absolute failure of the wound to heal, although convalescence for the first week was almost afebrile. The wound opened up throughout its entire length and a loop of bowel protruded and the granulating process was exceedingly sluggish. At the same time, the patient's physical and mental condition were very bad. At the end of six weeks, as a result of diet and general medication, the acetone and diacetic acid had disappeared from the urine and also the sugar. The patient later developed a phlebitis, first in the left and later in the right leg, with occasional chills and rises of temperature, and succumbed rather suddenly seventy-eight days after operation to what was apparently a pulmonary embolus.

The history of this case as regards the gall-stone ileus is very typical of obstructions of this nature. The long duration of the obstruction before it became alarming to her medical attendants, is explained by the fact that these obstructions are seldom complete in the early stages, and there is an absence of strangulation of the bowel, while spasm

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of the muscle fibres of the intestine is, according to Duplay and Reclus, responsible for most of the obstructive symptoms. The characteristic symptoms, according to Barnard, are the sudden onset, the absence of pain and collapse until late in the attack, the incomplete obstruction and the absence of tenderness and distention of the abdomen. Vomiting is a prominent symptom, being severe and continuous, while jaundice and true biliary colic are generally absent in the case of large stones. The mortality is high. The development of a septic phlebitis was undoubtedly responsible for the lethal termination of the case seventy-eight days after operation, and this phlebitis was probably dependent upon the toxæmia due to prolonged obstruction, the diabetic condition, and the delayed wound healing.

DR. ALFRED C. WOOD said that he had had the opportunity of operating on three cases of gall-stone ileus. The first case was that of a woman about fifty-eight years of age, with no previous history of indigestion or other illness, with the exception that at eight months prior to admission to the hospital she had an attack of pain which was thought to be due to pleurisy. During the three months prior to coming into the hospital she had attacks of constipation alternating with diarrhoea. At the operation a gall-stone was found in the ileum about 6 inches from the cæcum. As this stone was faceted, other stones were looked for, and a second stone discovered in the act of passing from the gall-bladder to the duodenum.

In the second case the diagnosis was made on account of the history of an attack some months before, that strongly suggested a gall-stone attack. The stone was found in approximately the same situation as in the preceding.

In the third case, the stone was of larger size and had been arrested at about a foot from the valve. A very careful study of the patient's history will sometimes enable one to suspect the cause of the obstruction in these cases.

MULTIPLE CARTILAGINOUS EXOSTOSES

DR. ASTLEY P. C. ASHHURST read a paper with the above title, for which see page 167.

DR. GWILYM G. DAVIS said that not infrequently these cases of multiple exostoses are seen in early adult life and in youth, and he did not think there is much doubt but that evidence of them exists in infancy. It is well to bear this in mind; otherwise the disease will be considered a new and active one, whereas it is a congenital trouble and of old standing. In some cases, in which only one or two exostoses are seen,

SURGICAL TUBERCULOSIS

if the X-ray were applied other parts would be found to be involved. This would account for some of the single exostoses supposed to be started by trauma.

DR. JOHN H. GIBBON asked Dr. Ashhurst whether syphilis plays any part in this disease of multiple exostoses. That was one of the causes assigned to the condition in a very marked case in his hospital service last year in which practically every bone in the man's body was involved. That man had had syphilis, but it is quite possible that he had the disease before he developed syphilis.

DR. ASHHURST, in closing, stated that the evidence is against syphilis being an etiological factor.

CHROME ULCERS IN LEATHER WORKERS

DR. J. CHALMERS DACOSTA read a paper with the above title, for which see page 155.

Stated Meeting, held November 1, 1915

The President, DR. JOHN H. GIBBON, in the Chair

SURGICAL TUBERCULOSIS TREATED BY THE ROLLIER SUNSHINE METHOD

DR. A. BRUCE GILL presented four children who had been treated for surgical tuberculosis by the Rollier sunshine method. These children have been exposed to the sunshine in Philadelphia and at Longport, which is on the seashore below Atlantic City.

The first case is that of a child who had osteomyelitis of the femur, fibula, and bones of the foot of the right lower extremity, with numerous sinuses discharging. The child was immediately put upon the sunshine treatment. At the end of four months the sinuses are all practically healed. We not only expose the affected part, but the whole body for a short time each day, so that the skin will not blister.

The second case was one of tuberculosis of the hip-joint; winter before last the child was extremely ill. The skin and soft tissues had melted away and exposed the neck of the femur, the great trochanter and three or four inches of the shaft. There was high temperature. In February of last year treatment was begun, at which time the child weighed 41 pounds. The first of June it was sent to the seashore and there the weight came up to 48 pounds. All through last winter the child was exposed to the sunshine whenever there was any and by the end of this summer the weight came up to 61 pounds. The child is now

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quite well and is going to school for part of the day. Her wound is healed.

The third case is one of Pott's disease. A year ago an Albee's transplant was put in the spine. There was pus present at the time of the operation and the wound did not heal. Three or four weeks after operation there were signs of pulmonary tuberculosis. There were râles, cough and temperature. The child was put into the sunshine and after several months' time the sinuses healed up, after a small part of the transplant had come away.

A fourth child has a tuberculous hip-joint and is still kept in bed. At first the affected part itself is exposed and gradually the entire body.

It is worth while knowing that this treatment can be carried out in this climate. It is valuable in both tuberculosis and infected wounds.

DR. WILLIAM J. TAYLOR said that he was personally very much in favor of this method and had been advising it for some little time. In a tuberculous hip-joint where there was a sinus discharging for many months, under this form of treatment the wound has healed and the general benefit to the patient has been very great. At the Orthopædic Hospital the children are put out on the roof and kept exposed to the sun all day. The benefits are really very great.

IMPRESSIONS OF THE SURGERY OF THE EUROPEAN WAR

Dr. EDMUND B. PIPER (by invitation) read a paper with this title, for which see page 208.

DR. CHARLES McDONALD and DR. JOHN F. MCCLOSKEY also gave some personal reminiscences of recent experiences with war surgery in Europe.

DR. RALPH BROMER (of Louisville, Ky.) stated that he served as House Surgeon of the American Ambulance during the months of September and October, 1914. The mortality rate was high owing to the fact that during the retreat from Belgium the ambulance corps of the French and British armies were practically out of commission. Some of the wounded were from six to nine days without treatment. In eighteen deaths occurring on his service four were from tetanus and two from gangrene of the lung. He did not remember the exact number of amputations for gas infection. The cases too sick for operative interference were treated by administering oxygen under the skin in the good tissue around the wound. Quite a number of deaths also occurred because of secondary hemorrhage, this at times being quite sudden in its appearance. One man with a wound of the superior maxilla died quite suddenly on the fourteenth day from severe secondary hemorrhage. The point of hemorrhage could not be found at autopsy.

STRAUS'S METHOD OF FIXING FRACTURES

STRAUS'S METHOD OF FIXING FRACTURES

DR. JOHN B. ROBERTS said that surgeons often wished for some way of fixing fractures with something less troublesome than steel or metal bodies. He called attention to a recent paper by Dr. Straus, of Chicago. Straus makes a mattress of catgut to support the line of fracture and puts a plaster-of-Paris bandage outside. It occurred to Dr. Roberts to take a piece of fascia of the subject, coapt the bone, and place the fascia which later would become absorbed. To make the part a little more rigid a drill pointed nail could be used. This method ought to be better than putting in metal flaps. His idea was to modify Straus's original plan by using a piece of fascia from the thigh of the subject. Dr. Roberts further discussed the subject in a paper, for which see page 182.

BOOK REVIEWS

OPERATIVE GYNÆCOLOGY. By HARRY STURGEON CROSSEN, M.D., Associate in Gynæcology, Washington University Medical School. Six hundred and seventy pages with seven hundred and seventy illustrations. St. Louis, Missouri: C. V. Mosby Company, 1915.

THE author of this book writes with a positive pen dipped in a wide experience and a strong personality. He leaves no one in doubt as to his position upon mooted questions.

To quote briefly from the preface he says, "The time is ripe for a systematic presentation of the various operative procedures available for the treatment of each gynæcologic lesion. Gynæcologic surgery is entering a new stage of development. The past may be designated the period of invention of methods. To such an extent has this been carried that for the treatment of uterine displacement alone more than one hundred operative procedures have been devised. The new stage of development may be designated the period of adaptation of operative methods to the exact pathological conditions present in the individual patient."

About one hundred pages are devoted to the subject of retrodisplacement of the uterus, describing in detail the technic of "methods which have been so far perfected as to be considered of practical use to-day."

The treatment of prolapse of the uterus and bladder is classified under the same two great headings used in considering retrodisplacement, namely, (a) patients past the menopause; (b) patients before the menopause. The classification is further continued according to the pathology of the individual case.

It is worthy of note in these days of increased and increasing use of absorbable suture material that Crossen states, in connection with tracheloplastic operations, "silk-worm gut is the suture material of preference, except when the pelvic floor is repaired at the same time."

The chapter upon extra-uterine pregnancy is thorough, the author being in accord with that increasing group of gynæcologists who believe in a more conservative treatment "even in the so-called tragic cases."

The chapter upon carcinoma of the uterus is excellent, it includes a thorough, accurate description of Percy's contribution to this subject. We wish the author had omitted the reference to Heitzman's sulphate

BOOK REVIEWS

of copper test for carcinoma of the cervix, since this experiment is known to be unscientific and unreliable.

In considering the injuries of the pelvic floor Crossen advisedly prefers the term relaxation rather than laceration as used in the Bellevue nomenclature.

In a work professing to set forth those operative methods "so far perfected as to be of considerable practical use to-day," it is to be regretted that he does not notice the remarkable work of Ristine, of Knoxville, Tennessee, in connection with complete tear of the pelvic floor.

After-treatment in abdominal section and vaginal operation is carefully treated, in an excellent manner. The volume is concluded by a chapter concerning medicolegal points.

We recommend the volume to the general practitioner who seeks accurate information in a department of science, and to the specialist who wants a reliable volume of ready reference on modern operative procedure.

FREDERICK C. HOLDEN.

THE RÖNTGEN DIAGNOSIS OF SURGICAL LESIONS OF THE GASTRO-INTESTINAL TRACT. By ARIAL W. GEORGE, M.D., Assistant Professor of the Department of Röntgenology, Tufts' College Medical School, and RALPH D. LEONARD, M.D., Assistant in the Röntgen Department of the Boston City Hospital. Boston, 1915: The Colonial Medical Press.

This attractive volume is a quarto of two hundred and eighty pages and contains, besides reproductions of three hundred and forty-three Röntgen plates, eighteen artist's drawings and seven three-color illustrations. The authors say that the purpose of the work is to demonstrate what one Röntgen Clinic has accomplished toward establishing a method for exact diagnosis in the common surgical lesions of the gastro-intestinal tract. The cases upon which the study is based are all taken from the private clinic of the authors, with a trifling exception. The diagnosis in each case is further checked up by operation, autopsy or unmistakable clinical course.

This is practically an atlas of the gastro-intestinal tract as revealed by the Röntgen ray. The plates given are uniformly clear and convincing, although it is true that their proper reading or interpretation can only be done by one who has had considerable practical experience in such work.

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The cases are divided into nine sections: (1) Normal stomach; (2) gastric ulcer; (3) gastric new-growth; (4) duodenum; (5) gall-bladder; (6) small intestine; (7) appendix; (8) large intestine; (9) diverticulitis. Each section is prefaced by a brief consideration of the routine and technic of the Röntgen examination of that particular segment of the digestive tract. No matters pertaining to clinical evidence or diagnosis are admitted.

The volume as a whole is of great value in presenting as it does, clearly and faithfully, so large a collection of plates for study and comparison.

LEWIS S. PILCHER.

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